RAILROAD GAZETTE

SATURDAY, SEPTEMBER 5, 1874.

CATECHISM OF THE LOCOMOTIVE.

By M. N. FORNEY, *Mechanical Engineer.*

PART XXIII.

PERFORMANCE AND COST OF OPERATING LOCOMOTIVES.

QUESTION 435. *What is the cost of operating ordinary locomotives per mile run?*

Answer. The average cost at the present time (1874) is from 20 to 25 cents per mile.*

QUESTION 436. *What items of cost are included in this and what proportion do they each bear to the total cost?*

Answer. The items of cost and the percentage of each to the whole expense of operating locomotives, and also to the total of all the expenses of operating railroads is given in the following table:

	Approximate average cost per mile run.	Percentage of total cost of operating locomotives.	Percentage of total cost of all the operating expenses of road.
Fuel	6.0 cts.	0.30	.06
Oil and waste	0.4 cts.	0.02	.004
Wages of locomotive runners and firemen	6.0 cts.	0.30	.06
Repairs of locomotives	7.0 cts.	0.35	.07
Cleaning locomotives	0.6 cts.	0.03	.006
Total	20 0 cts.	1.00	.20

From this table it will be seen that the locomotive expenses are 20 per cent. of the whole cost of operating railroads. This cost of course varies under different circumstances. The above is probably somewhat lower than the average cost in this country.

QUESTION 437. *How many miles do locomotives ordinarily run per ton of coal and per cord of wood?*

Answer. This also varies greatly under different circumstances. An average taken from the monthly reports of 52 different roads gives 38 miles run per ton of coal, and an average from the reports of 16 roads gives 47⅛ miles run per

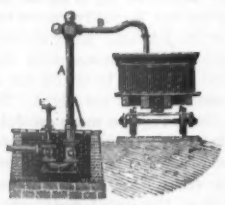


Fig. 226.

cord of wood. No deduction should, however, be made from this of the relative value of wood and coal for fuel, because the trains which are run with wood for fuel are usually lighter than those hauled with coal burning engines. The above figures are the average results during the month of May, 1871, of all the trains on the roads from whose locomotive reports it has been compiled. The following report of experiments, which were carefully made by the writer, will give the performance of a locomotive when great care is taken to produce good results. It may be stated that the engine had been in service eighteen months, without receiving thorough repairs, and the boiler at times primed badly, so that the rate of evaporation per pound of coal is not a fair indication of its performance in that respect. The coal used was known as Brazil coal from Indiana, and in order to compare the performance of two engines only lumps of coal were used, so as to leave no room for question regarding the relative amount of fine coal used by each engine. The maximum grades on the road on which the experiments were made were 30 feet per mile, and the total ascent from the lowest to the highest point on the road was 374 feet.

*Deducting 10 per cent. from this amount will give the gold value of the cost. The figures given above represent the cost in the depreciated promises to pay of the United States Government.

LOCOMOTIVE EXPERIMENTS.

	1873.	1873.	1873.
Date of experiment	July 21.	July 28.	August 2.
Number of miles run	145	145	145
Number of cars hauled	41	31	41
Total weight of cars, lbs.	1,497,240	1,119,650	1,508,860
Total amount of coal burned, lbs	8,676	5.102	7,221
Total am'nt of water consumed, lbs.	63,531	45,719	52,609
Water evaporated per lb. of coal, lbs.	7.32	8.02	7.04
Miles run per ton (of 2,000 lbs.) of coal	33.4	50.8	38.8
Coal consumed per car per mile, lbs.	1.45	1.13	1.21
Average speed, including stops, miles	11.1	13	13.8

QUESTION 438. *How can we determine the speed at which an engine is running?*

Answer. In the absence of any special instruments for the purpose BY COUNTING THE NUMBER OF REVOLUTIONS OF THE DRIVING-WHEELS PER MINUTE, THEN MULTIPLYING THE LENGTH OF THEIR CIRCUMFERENCE IN INCHES BY THE NUMBER OF THEIR REVOLUTIONS PER MINUTE AND THE PRODUCT BY 60, AND DIVIDING THE LAST PRODUCT BY 63,360. THE QUOTIENT WILL BE THE SPEED IN MILES PER HOUR. Thus, supposing driving-wheels which are 61⅛ in. in diameter, and whose circumference is therefore 193.2 in., should make 164 revolutions per minute, then

$$\frac{193.2\times164\times60}{63{,}360}=30, \text{ nearly} = \text{miles per hour.}$$

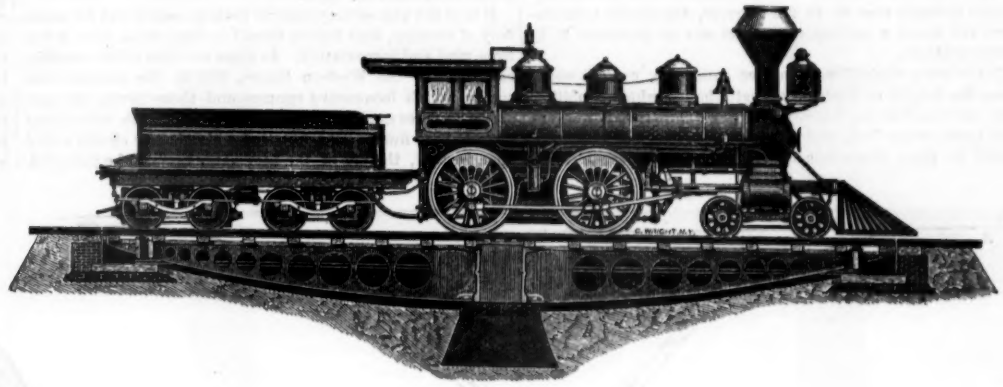


Fig. 227.

PART XXIV.

WATER-TANKS AND TURN-TABLES.

QUESTION 439. *How are locomotive tenders or tanks supplied with water?*

Answer. At suitable points, called *water stations*, along the line of the road large tanks or reservoirs are located, which are filled either from a natural stream which is higher than the tank and thus flows into the latter, or else the water is pumped in either by hand or by horse, wind, water or steam power. These tanks are usually, when there is room for them, located near the track, as shown in fig. 225, so that the water can be conducted by a spout, *a*, direct from the tank to the man-hole of the tender. Communication to and from this spout is opened and closed by a valve, *b*, inside of the tank. The spout is usually attached to the tank by a hinged joint, so that it can be lowered to the tender and then raised up out of the way of the engine and train. It is generally balanced by a counterweight, suspended to one end of a rope, which passes over a pulley and is fastened to the spout at the other end. Such tanks are now generally made of wooden staves like a tub or pail, and supported on a heavy frame made of wood, *c c c*, as shown in the engraving, or supported on stone or brick masonry.

When there is no room for the tank or reservoir near the track it is placed in any convenient position at some distance from it, and the water is then conveyed by an underground pipe to the place where the locomotives must take water. At the end of this pipe what is called a *water-crane*, fig. 226, is located. This consists of a vertical pipe, *A*, with a horizontal arm, *B*, which is made so as to swing around over the man-hole of the tender when the latter is to be filled with water. In some cases the horizontal arm alone swings around, but in others the vertical pipe turns with the horizontal one in a joint, *C*, underneath the surface of the ground. The latter plan is thought to be preferable to the first, as the pipe is less liable to freeze fast in the joint when the latter is underground than when it is exposed above. A suitable valve, *D*, is also attached to the pipe below ground, so that the stream of water can be turned off or on at pleasure by the wheel *E*.

QUESTION 440. *What considerations should determine the source from which a supply of water should be drawn?*

Answer. The first must of course be its convenience to the point where the water is to be used; but more attention should be given to the quality of the water than it ordinarily receives, as the effect of using impure water, or that which contains a considerable amount of mud or solid matter mixed with it, or in suspension, as it is called, or has lime or other mineral substances chemically combined with it, will very soon coat the inside of the boiler with a covering of scale, which is a very bad conductor of heat, and consequently the boiler is much less efficient and much more heat is wasted than if the heating surfaces were clear. Besides this loss of efficiency, when boiler plates are covered with non-conducting scale, they are much more liable to be injured by the action of the fire than when the water comes directly in contact with the metal of the plates. Some water, too, has a corroding effect on the metal of the boiler which is very destructive.

QUESTION 441. *How can the relative amount of incrustating substances in different kinds of water be determined?*

Answer. The relative quantity of solid matter or mud which is held in suspension can be at least approximately determined by simply filling vessels, say large clear glass bottles, with different kinds of water and letting them stand for some time until the solid matter settles to the bottom.

An easy method of precipitating the lime and some other salts which are held in solution and which will not settle until they are converted into a solid form is the following: Dissolve in a goblet of pure water (distilled, or freshly caught rain water) two or three teaspoonfuls of the *oxalate of ammonia*. Have equal quantities, say a goblet-full of each of the waters to be tested, ranged side by side and marked so as to be identified. Into each of these goblets stir equal quantities of the solution mentioned—about three teaspoonfuls will be enough—and let them stand for a day. The lime and some other salts will be precipitated and fall to the bottom as a powder; and the quantity of this precipitate in each glass will form a very good index of its relative injuriousness in the formation of scale.

When the oxalate of ammonia cannot easily be procured, an experiment may be tried, in the same way, by dissolving common white soap, or other pure soap, in a goblet of pure water, and then stirring into the glasses of water to be tested a few teaspoonfuls of this solution. The comparative amount of lime in the water will be shown by the amount of coagulated matter which will be thrown down.

QUESTION 442. *How are locomotives turned around on the track?*

Answer. The most common means employed for that purpose is a *turn-table*, fig. 227. This consists of two heavy beams made of wood, cast or wrought iron, placed side by side and resting on a pivot in the center on which they turn. They are placed in a circular pit below the level of the track, so that when rails are laid in the ordinary way on top of the beams they will be exactly level with the track which leads up to the pit. By turning the beams on the central pivot so that the rails will come exactly in line with the permanent track which leads up to the pit, the locomotive can be run on the turn-table which is then revolved a half-revolution, which of course reverses the position of the locomotive and brings it opposite the permanent track so that it can be run off of the table. In order to prevent the beams from tipping down when the engine first runs on or off of the turn-table, wheels are placed at their outer ends which run on a circular track and bear any inequality of weight that may be thrown on them if the locomotive is not equally balanced on the central pivot.

QUESTION 443. *How is the central pivot constructed?*

Answer. It usually consists of a vertical post, *A*, shown in fig. 228, which is a transverse section through the center of

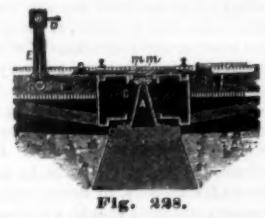


Fig. 228.

the turn-table, the end of which rests on hard cast-iron or steel bearings. In some cases, as shown in figs. 227 and 228, which represent a turn-table built by William Sellers & Co., of Philadelphia, the weight rests on conical steel rollers, *m m*, which revolve in a circular path formed in the top plates. Sometimes turn-tables are moved by a simple lever fastened so that several men can push against it and thus cause it to revolve. In other cases they are moved by a crank. *D*, fig. 228, which communicates motion by a system of wheels to a pinion which gears into fixed toothed segments under the turn-table.

QUESTION 444. *Is there any other method of turning locomotives?*

Answer. Yes; what is called a Y is sometimes used. This consists of a system of tracks laid somewhat in the form of the letter Y, as shown in fig. 229, in which *A B* is the main track, with two curves, *A C* and *B C*, laid as shown. If now it is desired to turn a locomotive which is standing in the position of the dart *A*, it is run on the curve *A C* to the position of the dart *C*. It is then backed from *C* on the curve *C B*, as represented, and when it reaches the main track in the

position of the dart *B* it is evident that its position will be reversed, as is shown if we compare the direction of the dart *A* with that of *B*.

PART XXIV.

OPERATION AND MANAGEMENT OF LOCOMOTIVES.

QUESTION 445. *What are the principal divisions of the work of operating or running a locomotive?*

Answer. They are: 1. Inspection and lubrication; that is an examination of the parts to see that they are in good working order, and the application of oil to the journals and other parts subjected to wear. 2. Setting the engine in motion and starting the locomotive and train. 3. Management while running. 4. Stopping the engine and train. 5. Laying up. 6. Management in case of accident. 7. Cleaning the engine.

QUESTION 446. *When the locomotive is inspected, what should be especially observed about the boiler?*

Answer. In the first place, all new boilers should be tested by pressure before being used, and ALL boilers whether new or old, SHOULD BE TESTED PERIODICALLY. The oftener the better. The ways of applying the pressure test are: 1, the cold-water test, that is, by filling the boiler with cold water and then forcing in an additional quantity with a force pump so as to raise the pressure to that at which it is intended to test the boiler; 2, the warm-water test, by filling the boiler entirely full of cold water and then kindling a fire in the grate so as to warm this water. As water expands about one twenty-fourth in rising from 60 to 212 degrees, the rise in temperature will cause a corresponding increase in pressure; 3, by steam pressure.

If the latter method were not so commonly used, it would seem the height of madness to test a boiler, which is neither more nor less than an attempt to explode it in the shop where it is built or repaired, and where the results of an explosion would be more disastrous and fatal than anywhere else, in

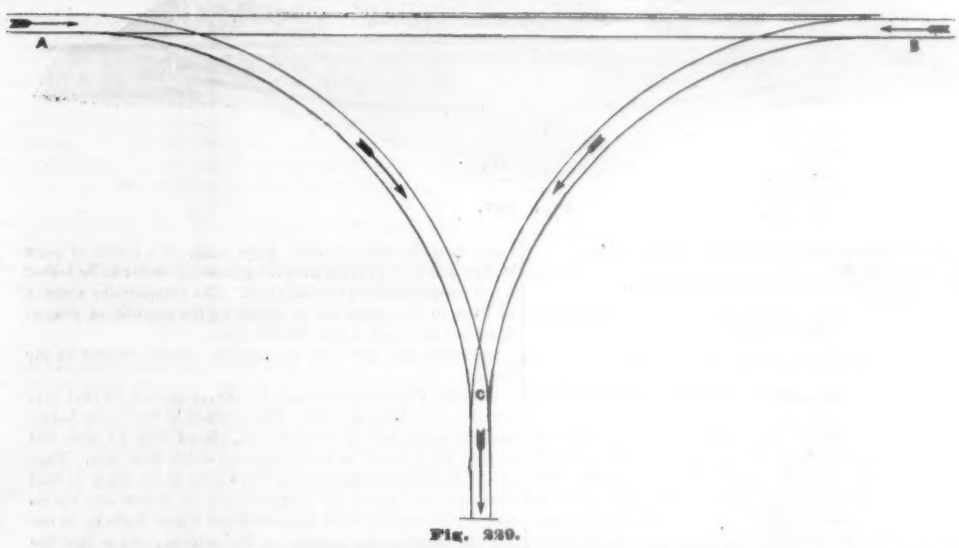


Fig. 220.

order to see whether it will explode when put into service on the line of the road. The danger of explosion is also increased at such times by hammering and caulking at leaky rivets and joints. It would seem, therefore, very much more rational to test boilers first by hydraulic pressure. For a first test this is preferable, because cold water will leak through crevices which would be tight when the boiler is heated, so that leaks can be more surely detected with cold than with warm or hot water. It is, however, doubtless true that boilers are often strained much more by the unequal expansion of the different parts than by the actual pressure. It is therefore thought that after the hydraulic test has been applied the second or warm-water test should be used. This can be easily done, as the boiler must be filled full of water for the first test. When the boiler is subjected to the test pressure, it should be carefully examined to see whether any indications of weakness are revealed. Any material change of form or any very irregular change of pressure is indicative of weakness. The flat stayed surfaces should be carefully examined by applying a straight edge to them before and after they are subjected to pressure to see whether they change their form materially. One of the greatest dangers and most common accidents to locomotive boilers is the breaking of stay-bolts, to detect which a locomotive runner and master mechanic should exercise constant vigilance.† While the pressure is on, the outside surface of the boiler should be thoroughly examined with slight blows of a hammer, which will often reveal a flaw in the metal or a defect in workmanship. After the hydraulic and warm-water tests have been applied, the boiler should be emptied, and the inside examined carefully to see whether any of the stays and braces have been broken or displaced by the test. After this has been done, and not until then, should steam be generated in the boiler. In making the latter test, it would doubtless be more safe to employ a pressure somewhat lower than that employed with the cold and warm water. There is great diversity of opinion regarding the maximum pressure which should be employed in testing boilers. It is doubtless true that a weak boiler might be injured and thus made dangerous by subjecting it to a very severe pressure, while without such a test it would have been safe. Recent experiments have indicated, however, that in most cases the ultimate strength of material is actually increased by subjecting it to a strain which even *exceeds* the elastic limit, provided such a strain is imposed only a few times. Although no absolute rule can be given to govern all such cases, it is thought that for the hydraulic and warm-water tests, a pressure about 50 per cent. greater and for the steam test 25 per cent. greater than the maximum working pressure should be employed.

†Those near the top of the fire-box are the most liable to break.

Before old boilers are tested, they should be very carefully examined, both inside and outside, to see whether they are injuriously corroded. It is to be regretted that the insides of locomotive boilers are usually made so difficult of access that it is impossible to discover the extent and the effects of corrosion without the most careful examination. This is not possible without getting inside of the boiler. Whenever this can be done a prudent locomotive runner should use the opportunity of inspecting the boiler of his engine himself, and not depend upon the boiler-makers who are employed for that purpose. He should remember that it is his life and not theirs which is exposed to danger by any weakness or defect in the construction of the boiler of the locomotive which he runs.

Before starting the fire in a locomotive, the fire-box should be carefully examined to see if there are any indications of leaks, which will often reveal cracked plates, defective stay-bolts or flues. If the latter simply leak at the joints, they can generally be made tight by caulking or the use of the tube expander. This is easily done when the engine is cold, but if not attended to may be very troublesome on the road. Leaks at other parts of the boiler should be examined, as they may reveal dangerous fractures.

It is of the utmost importance, both for safety and for economy of working, that boilers should be kept clean, that is free from mud and incrustation. In some sections of the country, especially in the Western States, this is the greatest evil against which locomotive runners and those having the care of locomotives must contend. The cures which have been proposed are numberless, but that which is now chiefly relied upon is, first, the use of the best water that can be procured, and second, frequent and thorough washing out of the boiler.

QUESTION 447. *What sort of examination should be given to the boiler attachments?*

Answer. It should be observed whether the grate-bars or drop-doors of the grate are properly fastened, and whether the ashes have been cleaned out of the ash-pan, and also whether the fire is clean, that is, whether the grates are free from cinders or clinkers. The height of water in the boiler should be observed by testing it with the gauge-cocks and by noticing it in the glass gauge, if one of the latter is used. It is also well to blow out the sediment and mud from the latter before starting, and to see that the valves which admit steam and water to the glass are open. They should, however, be opened only a very short distance, so that only a small quantity of steam or hot water will escape in case the glass tube should be broken. The injector, if one is used, should be tested to see that it is in working order, and as soon as the engine starts out of the engine house both of the pumps should also be tested in order to see whether they are in good working condition. The safety-valves should be raised so as to be sure that they are not rusted or otherwise fastened to their seats. There is no part of a locomotive more liable to disorder than the steam gauge. For this reason it should be frequently tested, and whenever there is any indication of irregularity in its action it should be examined. As the wire netting on the smoke-stack often has holes cut into it by the action of the sparks, it should be frequently examined to see whether it is in good condition. It is also liable to be "gummed up," especially if too much oil is used in lubricating the cylinders and valves. As soon as holes are cut into the netting there is danger that the sparks which escape will set fire to the combustible material near the track, and if the netting is gummed up the draft will be obstructed and the engine will not make steam. The gummy matter can often be removed by building a wood fire on top of the netting. In this way the oil in the gummy matter is burned up, which leaves a dry material which can then, at least to some extent, be beaten out of the netting.

QUESTION 448. *How can it be known whether the pumps are working well?*

Answer. Their operation is indicated by the force of the stream which escapes from the pet-cock when it is open. When the pump is in good condition the water begins to escape promptly in a strong stream as soon as the pump-plunger begins its inward stroke, and continues to escape until the plunger completes its stroke. If the pump is not in good condition, this escaping stream is weak and is apt to continue during the outward stroke of the pump-plunger. It is difficult to tell, however, when the engine is running slowly, whether the pump will work well at higher speeds, and therefore a locomotive runner should always test the condition of the pumps during the previous run.

QUESTION 449. *What should be noticed in connection with the throttle-valve?*

Answer. As a failure of the throttle-valve to work may be the cause of a most serious accident, it should be certain that it is in good working condition, that all the bolts, pins and screws and other accessories are in good working order. It should also be known whether the throttle-valve is steam-tight. This can be learned by observing whether steam escapes from the exhaust-pipes or cylinder-cocks when the latter are open, the reverse lever in full gear and the throttle-valve closed. If the throttle-valve leaks, enough steam may accumulate in the cylinder when there is no one on the engine to start it, and in this way cause a serious accident. The throttle-lever should always be fastened with a set-screw or latch of some kind when the engine is standing still.

QUESTION 450. *In inspecting the cylinders, pistons, guides and connecting-rods, to what points should the attention be directed?*

Answer. It should be known whether the piston packing is properly set out, that is whether it is so tight that it will not "*blow through*," or leak steam from one end of the cylinder to the other, which of course will waste a great deal of steam. Of the two evils it is, however, better to have piston packing too loose than too tight, because if it is too tight it is liable to cut or scratch the cylinders so as to make it necessary to rebore them, and at the same time if the packing rings are lined with Babbitt metal the heat created by the intense pressure and friction will melt the metal. In some cases the cylinders become heated to so high a temperature from this cause that the wood lagging with which they are covered on the outside is burned.

Fig. 96.

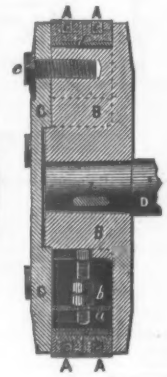


Fig. 97.

The packing of the piston-rods should be steam-tight, and it should be observed whether the rod and the pump-plunger are securely attached to the cross-head.

The utmost care must be exercised to keep the guides well oiled. The oil cups on the guide-rods or cross-heads, when they are placed on the latter, must be kept clean, so that the oil will flow freely, and yet not too rapidly, on the surfaces exposed to friction. The same thing is true of the oil cups on the connecting-rods. Attention should be given to the brass bearings of the connecting-rods to see that they are not so loose as to thump, nor keyed so tight on the crank as to be liable to heat. The latter can be easily known by moving the stub-end lengthwise of the journal. They should never be so tight that they cannot be thus moved with the hand. Especial attention should be given to seeing that all the bolts and nuts on the connecting rods are tight. There are no parts of a locomotive which require more careful attention in order to keep them lubricated and thus prevent them from heating and being "cut" than the bearings on the crank-pins and the slides of the cross-head. Examination should be made to see that neither the piston-rods, pump-plungers, guides, connecting-rods nor crank-pins are bent or sprung.

QUESTION 451. *How can it be known whether the piston packing is too loose or "blows through?"*

Answer. It can usually be noticed in the sound of the exhaust, which can be heard very distinctly on the foot-board when the furnace door is opened. If the packing is not tight it produces a peculiar wheezing sound between and after each discharge of steam. If the packing leaks, steam will escape from *both* the cylinder cocks, if they are open, just after the crank passes the dead point. This will usually show in which of the cylinders the packing is too loose. The same thing will occur, however, if either or both of the main valves leak, so that it is often hard to determine whether the "blow" is due to a leak from the valve or from the piston. Of course it may sometimes happen that both leak, or that the piston on one side and the valve on the other leak, so that often the diagnosis, as the doctors say, of the disease is extremely difficult. Careful observation and experience will, however, aid a locomotive runner in detecting such defects much more than any directions which can be given here.

QUESTION 452. *What is meant by "setting out packing," and how should it be done?*

Answer. "*Setting out packing*" is simply expanding the rings when they get too loose. With ordinary spring packing, figs. 96 and 97, which is now generally used, this is done by screwing up the nuts *b*, *b*, *b*, which, as was explained in answer to Question 164, compresses the springs *a*, *a*, *a*, and thus expands the rings *A*, *A*. In doing this, as already stated, great care must be exercised not to screw the nuts up too hard, and it is always better to have the packing too loose than too tight. Care must also be taken to keep the piston-rod in the center of the cylinder, otherwise there will be undue pressure and wear on the stuffing-box. After the nuts are screwed up the position of the piston-head should be tested with a pair of callipers. This is done by placing one leg of the callipers against the side of the cylinder and setting them so that the other leg will just touch the edge of the projection *E*, fig. 96, or the end of the piston-rod. Then by placing the callipers above and below and on each side of the piston, it will appear whether it is too high or too low or too near either side; then by loosening the nuts on one side and tightening them on the other it can be moved to a central position. Ordinarily this work is intrusted to persons who are employed for the purpose. A young locomotive runner, fireman or mechanic will, however, always do well to familiarize himself with such duties and, if possible, do it himself under the direction of those who are skilled in that kind of work.

QUESTION 453. *If the stuffing-box of the piston-rod leaks, what should be done?*

Answer. If the packing in it is in good condition it can usually be made tight by simply screwing up the gland. In doing this the two bolts must be screwed up equally, otherwise the gland will be "canted," that is, inclined so as to "bind" or bear unequally and very hard on the piston-rod, and thus be liable to cut or scratch it. After packing has been in the stuffing-box a long time it becomes very hard and compact and sometimes partly charred. Then either it must be removed and new packing be put in, or, if in tolerably good condition, it can often be made to work well by simply reversing it, that is, by putting that which was at the bottom of the stuffing-box on top and *vice versa*. Before packing is put into a stuffing-box it should always be thoroughly oiled.

QUESTION 454. *When the sides of the cross-heads wear, how is the lost motion taken up?*

Answer. When there are gibs on the cross-head the lost motion can be taken up by putting "*liners*" or "*shims*," that is, thin pieces of metal, between them and the cross-head, so that they will fill up the space between the guide-bars. When there are no gibs, the guide-bars must be taken down, and the blocks between them at each end must be reduced in thickness so as to bring the bars nearer together. In doing this great care must be taken that the guides are accurately "in line" with the center line or axis of the cylinder. This work should never be intrusted to any excepting skilled workmen, from whom those who are inexperienced should seek instruction.

QUESTION 455. *When the brass bearings of the connecting rods become too loose on their journals, what should be done?*

Answer. They must be taken down, and the two surfaces in contact must be filed away so as to bring them closer together. In doing this they must be filed square with the other surfaces, otherwise they will not bear equally on the journals when they are keyed up. Before attaching them permanently to the rods, they should be keyed on the journal in the strap alone, so that it can be known by trial whether they move freely and yet are tight enough to prevent thumping on the journal. When they are attached to the rod it is very important, especially with coupling or parallel rods, that the correct length from center to center of the bearings be maintained. It is much better to leave coupling-rods loose on their journals, as they will not thump if their length is the same as the distance between the centers of the wheels. If the bearings are keyed up tight, the rods are sure to throw an enormous strain on the crank-pins, because the distance between the centers of the axles is not always absolutely the same, owing to the rise and fall of the axle boxes in the jaws. It is therefore always best to have a little play in the parallel rods, and it is safe to say that much more mischief is done by meddling with the coupling-rod brasses than by neglecting them.

QUESTION 456. *What parts of the valve gear should receive attention when the engine is inspected?*

Answer. All the bolts, nuts and keys should be carefully examined to see that they are properly fastened. The bolts and nuts in the eccentric straps are especially liable to become loose, and as they are between the wheels, and therefore not easy of access, are often neglected. The oil-holes should all be seen to be clear, otherwise it will be impossible to keep the journals well oiled. The eccentric straps and the link blocks are very liable to be imperfectly oiled, and when the former become dry and cut they throw a great strain on the eccentric-rods, which is liable to break them. When this occurs the strap and the portion of the strap which is attached to it revolve with the eccentric and frequently a hole is thus knocked into the front of the fire-box, which disables the engine. The valve gear is, with the exception, perhaps, of the pumps and injector, the most delicate part of the locomotive, and more liable to get out of order than any other, and should therefore be watched with the greatest care.

QUESTION 457. *How can it be known whether the main valves of a locomotive are tight?*

Answer. As already indicated, the symptoms which manifest themselves when a valve leaks are very similar to those which appear when the piston packing leaks. If the valve is moved to its middle position and steam is then admitted into the steam-chest, and it then escapes from both cylinder cocks, it is apparent that the valve is not tight. But the valve faces of locomotives usually wear concave, because the valves are worked most about half-stroke, so that they will often be tight when in the center of the face, but will leak at the ends of the full stroke. This will become apparent by the peculiar wheezing sound, already referred to, when the engine is at work. As has been explained, it is, however, often very difficult to determine whether this sound is due to a leak at the pistons or the valves. If the packing of the valve-stem leaks, it can be remedied in the manner described for making that of the piston-rod tight.

QUESTION 458. *To what points of the running gear should attention be directed during inspection?*

Answer. All the wheels of the engine and tender should be carefully examined to see that they are sound. By striking cast-iron wheels with a hammer, their condition if safe will be revealed by a peculiar clear ring, whereas if they are fractured the sound produced by the blow of the hammer will be dead, like that of a cracked bell. The flanges of the wheels should also be carefully examined to see that they are not broken, as such a fracture is not always revealed by the sound produced by a blow from a hammer. The axles should be examined to see that the wheels have not worked loose on the wheel-seat. When this occurs it often becomes apparent by the oil from the axle boxes working through between the hubs of the wheel and the axle. This can be observed on the outside of the wheels when the bearings are inside, and inside the wheels when the bearing is outside.

The springs should also be examined to see that they are in good condition, and the oil-holes in the boxes must be kept clear so that the oil can reach the bearings. The tender boxes are kept oiled by packing them with cotton or woolen waste saturated with oil. This should be taken out occasionally and renewed and the boxes cleaned. The working of the driving-boxes up and down in the jaws will in time wear them so that there will be some lost motion in the jaws. This will be indicated by a thump when the cranks pass the dead point. A similar thump will, however, be produced by lost motion in the boxes of the main connecting-rod, so that it is difficult to determine, without special examination, the cause which produces the concussion. It is therefore best when an engine works with a thump at each revolution for the runner to stand by the side of it where he can touch the connecting-rods and driving-wheels and then have the fireman open the throttle-valve so as to move the engine slowly. If the lost motion is in the connecting-rods it can be felt by the jar as it passes the dead points. The same is true of lost motion in the jaws, which can be felt by touching the driving-wheels. When the jaws become worn the lost motion can be taken up by moving up one or both of the wedges. When this is done, great care must be taken to keep the centers of the driving-axles the same distance apart on both sides of the engine, and also to keep their center lines square with the frames. There should always be center-punch marks placed on the frames or guide-yokes on each side of the engine in front of the main axle, and at equal distances from its centers, so that when the boxes or jaws become worn the position of the axle can be adjusted with a tram from these marks. Of course if the main axle is square, it is easy to adjust the trailing axle from it with a tram. If the axles are not square with the frames and parallel with each other, the engine will run towards one side or the other of the track, according to the inclination of the axles. It sometimes happens that the bolts which hold up the wedges in the jaws are broken. When this occurs the wedge drops down, and of course the box has so much lost motion that it soon manifests itself in the working of the engine. These bolts, and also those which hold up the clamps on the frames at the bottom of the jaws, should be examined when the engine is inspected, so as to be sure they are in good condition. The bolts and nuts about both the engine and tender trucks should be watched to see that none are lost or work loose. The engine and tender should occasionally be lifted up from the center plates of the truck, and the latter be lubricated with tallow. It often happens that these become dry, so that they are difficult to turn when the weight rests on them, and therefore they will not adjust themselves easily to the curves of the track.

Whitton's Safety Wheel.

The object of this invention is to lessen the danger of railroad wheels leaving the track. Each wheel, as shown in the engraving, has double flanges, one of them a supplementary flange which is outside of and immediately connected with the other. The object of these supplementary flanges is, in case the ordinary flange should run on top of the rails, to prevent the wheel from leaving the track. If prevented from leaving the rails, the natural tendency of a displaced wheel is immediately to run back into its former position on the rails.

Fig. 1.

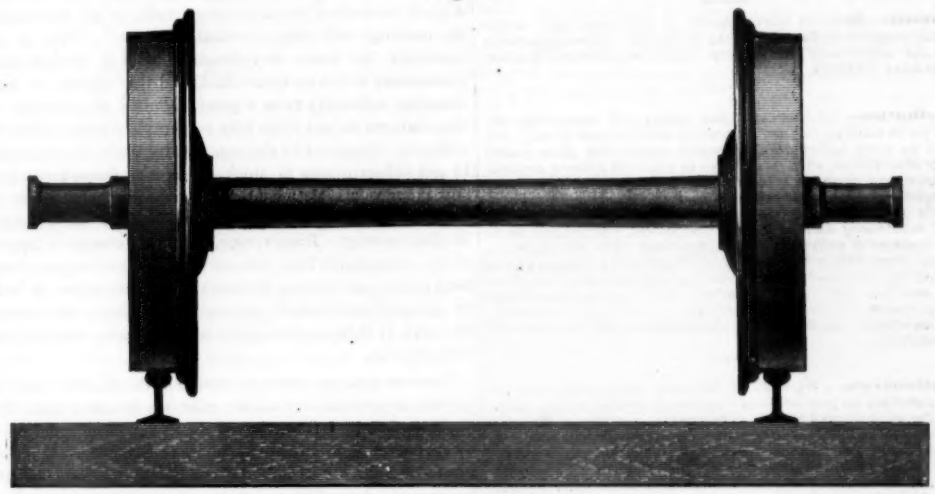
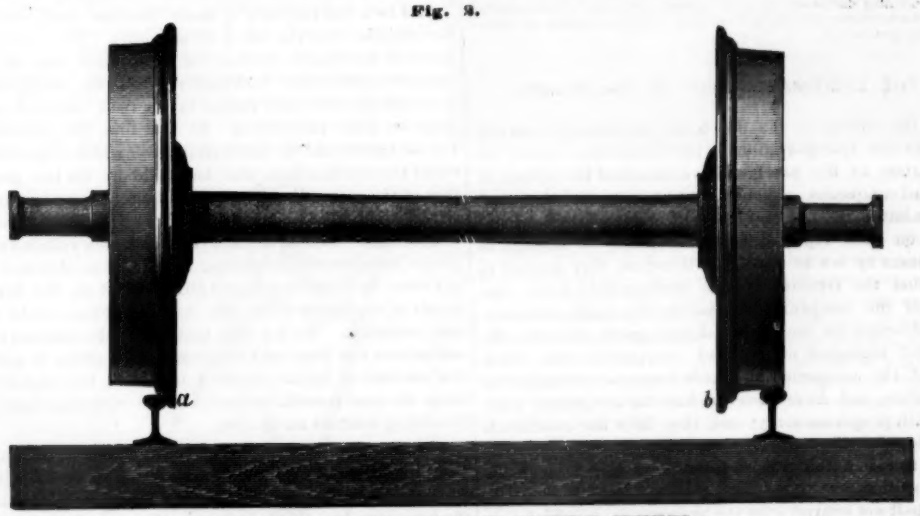


Fig. 2.



WHITTON'S DOUBLE FLANGE SAFETY WHEEL.

Fig. 1 represents the wheels in the ordinary position on the rails when in use. In fig. 2 the flange *a* is represented as having mounted on top of the rail and the wheel is thus prevented from running off by the supplementary flange as shown.

The inventor claims for this, that it will make all kinds of rolling stock safer on bad tracks, sharp curves, precipices, embankments, at high speed, and can be used on any existing railroad. The effect of its use is, he says, substantially to utilize a greater depth of rail than with the ordinary flange. He requests railroad companies and manufacturers of rolling stock to avail themselves of its advantages. His address is Ashton E. Whitton, Des Moines City, Iowa.

British Rail Exports.

The exports to the United States during July amounted to 7,662 tons in 1874, against 13,925 in 1873, the decrease being 45 per cent. For the seven months ending with July the exports were 72,631 tons in 1874 against 134,393 in 1873, showing a falling off of 46 per cent. The exports to all countries were about 80,000 tons, or 19 per cent. more this year than last for the seven months. The large increases are to Russia, Sweden and Norway, Australia and British India. Last year we took nearly 32 per cent. of the total British exports, this year but 14½ per cent.

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Editorial Announcements.

Addresses.—*Business letters should be addressed and drafts made payable to* THE RAILROAD GAZETTE. *Communications for the attention of the Editors should be addressed* EDITOR RAILROAD GAZETTE.

Contributions.—*Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies, the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and in their management, particulars as to the business of railroads, and suggestions as to its improvement. Discussions of subjects pertaining to* ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

Advertisements.—*We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay,* EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and those only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially, either for money or in consideration of advertising patronage.*

THE LEGITIMATE COST OF RAILROADS.

In the course of the discussion on railroad laws and charges for transportation in the Northwest, some of the supporters of the new laws have examined the returns of railroad companies sufficiently to be convinced that most of the latter are not and have not been earning a fair income on their reported cost. To justify an attempt to force them by law to earn less, therefore, they attempt to show that the reported cost is unreasonably large, that many of the companies were assisted by means of municipal subscriptions and national land grants, that the officers and managers of railroad companies have often cheated the companies and made fortunes for themselves and others, and do not now conduct the companies' business with proper economy; and they draw the conclusion from this that the railroad companies should not be permitted to earn a fair rate of interest on what their roads have cost them.

We shall not quarrel with the premises from which this conclusion is drawn. In innumerable cases charges are made where they are not justified, but it will not be difficult to find cases in which they are true. Corrupt contracts have been common; blundering engineering has been common; diversion of roads from their proper routes, for the advantage of individual managers, has been common, and by all these, the railroads have been made to cost the companies more than they might; and a continuance of corrupt practices and ignorant practices on the part of the managers makes it cost more to work them than it might. On the other hand, the contributions of the owners towards the present cost of the roads have been lessened by the contributions of the public—of municipalities in the form of bonds, and of the nation in the form of public lands. What then?

First, as to the contributions of the public to the cost of construction, we should bear in mind the purpose of such contributions, the circumstances which made them needful, and which alone made it possible to get them.

When a project for a railroad is formed, if it appears likely to earn a fair income on the investment from the beginning, there is no need of municipal subscriptions. The road promises to be productive in two ways: first by increasing the value of the fixed property in its vicinity, and second by earning an income from its traffic. Though the latter benefit may be—and where the line is through a country destitute of facilities for transportation almost always is—a trifle in comparison with the former, still the projectors of the road are not likely to call for subsidies from the community, and would not get them if they did, for the reason that the property-owners know that they can secure this improvement without such subsidies, capital always being willing to be invested where it will pay. But when the proposed road will not be able for a time, long or short, to earn a fair income on the investment, or when it seems to capitalists that it will not, then of course the future prospects of the road will not induce capitalists to invest their money in it. The community may say and may prove, as nearly as such things can be proved, that if you put your money in this road, in the course of three, five or eight years you will get seven, eight or ten or even twelve per cent. on your money. But you will very likely answer: "But what shall I do meanwhile? I can get ten per cent. for my money now, without waiting eight or ten years for a return, and if I were to invest it at that rate to-day my hundred thousand dollars would have grown to two hundred thousand before your road would pay eight per cent. on one hundred thousand." It is then that the community is likely to say: "Our property will be worth two millions more the day that this railroad, costing a million, is fairly at work. We will give the company bonds or land worth two, three or four hundred thousand dollars, which will enable it to pay a good interest on the investment until, in all probability, the earnings will suffice for that purpose." This is substantially the basis of railroad subsidies, though as the community is not an individual, and the capital is usually supplied indirectly from a great number of persons, the negotiations do not often take so simple a form. But the company organized by the community finds it impossible to get subscriptions to stock or bonds from capitalists, and the reason is because the latter do not believe that the road will, for sometime at least, be able to earn interest on their money. Discovering this, the company appeals to the community for a vote of bonds or to Congress for a land grant, and having obtained one or the other or both, or perhaps individuals subscriptions along the route of the road, it then appeals again to capitalists, and perhaps with success.

Now our aim has been in getting at the motives and occasions of government aid to railroads to show that they are intended, and from the nature of the case must be in most instances, to insure an income when otherwise there would be none, or an uncertain or insufficient one, usually in the early days of the road, but possibly permanently.

And in a vast majority of cases this has been not only the purpose but the effect of subsidies. The vast land grant of the Illinois Central for some time was all that stood between it and bankruptcy, while the stockholders who had invested their money in the road received no income on their investment. At that time the proceeds of the land grant and the borrowing power which it gave alone saved the stockholders, who had paid by far the greater part of the cost of that great road, from losing permanently the principal of their investment, as well as the interest temporarily. And so in most cases in which railroad companies have received subsidies; the money so obtained was not more than enough to pay fair interest on the investments of capitalists when the road otherwise could not have earned it. We say then that, as a rule, railroad subsidies have not been used or intended, in effect, to reduce the amount of capital invested in a road, but simply to make the road possible before it would otherwise exist, by providing interest on its cost.

Turning now to the charges of unnecessary expenditures by dishonest or incapable agents of companies, it is worth while to inquire who, next to the men committing the acts complained of, is responsible for their doings? How were such acts possible? How is it that in a long series of years such practices were not broken up? How comes it that it has been so easy to cover the evidences of them? Why have not some of these peculators received punishment for their misdemeanors? This is important, for there is no question as to the parties whom some of the Western communities now propose to punish through their new laws. These aim at the proprietors of the roads, at the stock and bondholders. Are these men responsible for the acts of those who have wasted their money and are misusing their property? Why they are the very men who have been robbed. The injury to them is much greater than that to the whole community. They have had from the first and always will have a hundred-fold greater inducements than anyone else can have to make their agents act honestly and to enforce a wise and economical expenditure of their money and administration of their property. That they had not made efforts to these ends would prove them neglectful of their own interests to an incredible degree; that they have made such efforts and have not always been able to succeed would simply prove that the business of building and working railroads is liable, like all business conducted by great corporations, to manifold abuses and mistakes, which form part of the contingencies of all undertakings involving the expenditure and receipt of money, and must always be allowed for; that they have made such efforts and have failed to a degree unusual even in such enterprises—what does that argue? It argues that in the communities where the railroads are built the laws pay too little attention to the rights of stock and bondholders and the obligations of their agents; that the community has made it easy to defraud investors, and hard to discover and punish the offenders; that, in short, the State has not sufficiently protected investments made by non-residents. And this is the truth. What remedy have German and Dutch bondholders found in the not infrequent cases where their money has been obtained of them by false pretences and wasted or stolen afterwards? Who cares for Dutch bondholders in the Northwest? What effort has been made to render illegal those practices by which, it is charged, railroad companies are robbed for the benefit of certain contractors or other persons? None that we can learn; but now the community, having made these things possible and permitted them, turns to the railroad owner and says: "You have been robbed, I learn, and now I shall fine you for it, even to the confiscation of your property." In New York many millions of dollars of the obligations of a single company were imposed upon it directly in consequence of the action of the State Legislature and in spite of the stockholders. Who is responsible for this abuse? Who but the people of the State of New York represented in the General Assembly.

After all, the effect of these abuses *on the community* is exaggerated. Nearly all roads have to carry for what they can get, and cannot charge whatever may be necessary to make up full interest and dividends. The roads on which such abuses have occurred to a great extent become bankrupt for the most part, and a large class of investors in them suffer a total loss. The hundreds of millions lost in this way, from first to last, in the United States, will much more than balance any existing unnecessary additions to cost by corrupt practices, and we may reasonably meet the charge that their capital accounts are unnaturally bloated by a comparison with those of other countries.

If American railroads have been extravagantly built, and their reputed cost includes a large proportion unwarrantably charged to construction, we should somewhere in the world be able to find examples of cheaper railroads, unless, by some miracle, Satan has got possession of railroad business everywhere, and the efforts of the shrewdest capitalists in the world, in all lands and under all kinds of laws, to buy and build as cheaply as possible have been in vain. An examination of the statistics of other countries, even those where labor and materials are much cheaper than here, will show that there is not one whose railroads are reported to have cost so little. The Milwaukee & St. Paul, which just now is subjected to the bitterest attacks, perhaps, has a capital account of but about $36,000 per mile, on only a part of which does it earn any interest, and there is no other country in the world, perhaps, where the average cost of railroads has not been twice as great, and very few lines in this country with lower capital accounts which have not had a large part of their capital wiped out by bankruptcy at some time of their existence. But the legislatures seem to have been quite as eager to reduce charges where the roads earn no dividends, or even where they do not earn their interest on their bonds and are half of them bankrupt already, as elsewhere. Indeed, it is almost true that there is least opposition to those railroads which make the greatest profits, those lines being usually the ones which have the heaviest business and the lowest rates. The average legislator's desire seems to be to compel the railroads to make low charges, without the slightest reference to the cost of doing the work. That he will know better in time is probable, perhaps, but he seems very slow to learn.

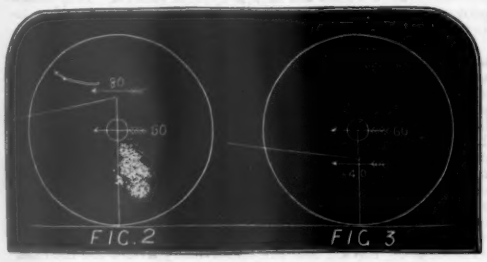
WHERE IS THE FULCRUM OF A DRIVING-WHEEL?

In the RAILROAD GAZETTE of August 1 a letter was published from Mr. Richard H. Buel, in which he calls attention to some "fallacies" regarding the above subject, which appeared as part of the "Catechism of the Locomotive," in the paper of July 25. In that letter Mr. Buel tries to show the error of the reasoning in the "Catechism of the Locomotive," by the process of *reductio ad absurdum*, which is of course all quite fair, if the premises on which such a process of reasoning is based are the same as those employed in the argument, which is thus intended to be reduced to an absurdity; but, if in a discussion of this kind quite different premises are assumed, and those quite erroneous ones, the logical reaction of which—to use a chemical term—is a *reductio ad absurdum*, then manifestly, the original argument is not weakened. Now, the fallacy in Mr. Buel's letter is the assumption, as shown in fig. 1, that the mean horizontal pressure on the crank-pin is 6,366 lbs. when that on the piston is 10,000. He has taken the mean pressure which the latter force would exert at right angles to the crank, and substituted it for what was assumed to be the horizontal force exerted on the crank-pin, in the reasoning he is trying to refute. It is a question of fact whether the mean horizontal pressure on the crank-pin is, under the circumstances named, 10,000 or 6,366 lbs. If it is the former, it is difficult to see how the original

deduction can be escaped; if it is the latter, we have the singular fact that at the dead points the pressure exerted against the cylinder-heads is 10,000 lbs., and that against the crank-pins is only 6,366, so that when the piston is at the one dead point, we would have a pressure of 3,634 lbs. urging the engine forward, and at the other one an equal force would urge it backward. We know that Mr. Buel does not say the horizontal pressure is 6,366 lbs.: he says simply "the mean pressure" is that amount; but he substitutes this latter for the true horizonal pressure employed in the reasoning, which thus with the altered premises seems an absurdity. It is this error which "gave rise" to his strange conclusions.

He further says that he "believes that the true principle of the action of the locomotive is the same as if the locomotive was fixed, and drew the train by means of a rope or chain wound round the driver."* Now if this action is the same, no change of condition would be necessary. There is, however, this significant fact, that before you could thus wind up a train, the locomotive must be fixed or fastened; otherwise the train would act like the tail of Dundreary's hypothetical dog and the locomotive would be wound up to the train. Now what do we do when we fasten a locomotive, say chain it fast by the frames? In doing this we give to the axle the very property which it requires in order to act as a fulcrum, that is *fixity*, a property which it had not before and therefore could not fulfill the function of a fulcrum, which is a fixed point about which a lever moves. If any other evidence were needed to show that when a locomotive is thus fastened the conditions are changed, we have it in the fact that it is necessary to run the engines the reverse way in order to wind up the train. In other words, to pull the train forward the engine must be run backwards and *vice versa*.

The fact that the engine is pushed forward by the pressure on the piston during its forward stroke, and by that on the cylinder-head during the backward stroke, is apparent, if we analyze the motion of the crank-pin and



axle during one revolution. Let, for example, fig. 2 represent a driving-wheel of six feet diameter and with two feet stroke, with the crank-pin above the axle. Now suppose the trains to be moving forward at a uniform speed of 60 feet per second. This would then be the speed of the center of the axle. The piston is now in the forward stroke and in the position in which it is represented it is urged forward by a pressure in that direction at a speed of 80 feet per second. The crank-pin is moved in the same direction and at the same speed by the pressure on the piston. When the crank-pin is below the axle, fig 3, the latter of course moves forward at the same speed, and the crank-pin moves *in the same direction* as indicated by the dart, but at a speed of only 40 feet per second. The pressure on the piston is now backward, and if the forward motion of the axle is due to the pressure on the piston, we have the anomalous fact of the crank-pin being moved *forward* by a backward pressure, without the direction of the resulting motion being reversed by any mechanical means, and at the same time we have it moving the axle in the same direction at a higher rate of speed. These phenomena all become very simple if we regard the backward pressure on the piston as a retarding force to the crank-pin, and the forward pressure on the cylinder-head as an accelerating force which acts on the axle.

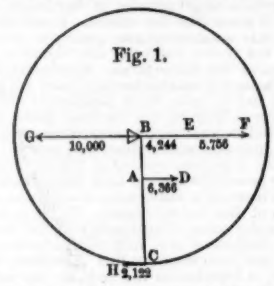
The "practical illustration" of an engine with vertical cylinders is at first a little confusing, but a little analysis of the action of the forces will, however, make plain the difference in the conditions of working. Fig. 4 represents such a cylinder and wheel with the piston at half-stroke, with the crank-pin in front of the axle, and fig. 5 with the crank-pin behind the axle. Now when the engine is moving in the direction of the darts *a*, *a*, it will be observed that the motion of the crank-pin during the upward and downward strokes is reversed, whereas in fig. 2 and fig. 3 it is in the same direction in both cases. As the direction of the pressure on the piston is always reversed during the revolution of the wheel, the impelling force must act differently when the crank-pin has a continuous forward motion, as in figs. 4 and 5, and when it has an alternately reversed motion, as in figs. 2 and 3. In figs. 4 and 5 the crank-pin is moved by the motion imparted to the piston; whereas in figs. 4 and 5 its motion during the forward stroke is due to that imparted to the piston, and during the backward stroke, to that of the cylinder-head.

* For the benefit of our English readers we will say that the driving-wheel is meant and not the man who runs the locomotive.

In order to show some of the "curious results" which "arise from the application" of Mr. Buel's figures to an engine with vertical cylinders, let us suppose that we have the same pressure on the piston in fig. 4 that was heretofore assumed. We then have an upward pressure on the top cylinder-head of 10,000 lbs., and a downward pressure on the crank-pin of 6,366, so that in this condition the weight on the wheel would be 3,624 lbs. less than when there was no steam in the cylinder. When the pressure is below the piston, as shown in fig. 5, then the downward reaction is 10,000 and the upward pressure 6,366, so that the weight resting on the wheel would then be 3,364 lbs. more than that due to the weight of the engine.

Regarding the position of the fulcrum, there is room for a great deal of difference in the meaning assigned to the term. The dictionaries all say that a fulcrum is a fixed

Fig. 1.



point about which a lever moves. Now fixed in relation to what? the surface of the earth, the center of the solar system, or to the weight to be moved? We believe in mechanics it always has the latter sense. Now the weight to be moved by a locomotive is the train, and therefore the fulcrum must be fixed as the train is fixed when it stands still. Now the only point about a locomotive in motion which is thus fixed is the point of contact of the wheel with the rail, and therefore we prefer to regard that as the fulcrum, but as stated in the "Catechism," so far as the result of the calculations which were there explained is concerned, it makes no difference which we regard as the fulcrum. To show the reasonableness of this view, that the point of contact with the rail is the fulcrum, we have had an engraving made, fig. 6, representing a person in the act of moving a block of stone which is mounted on rollers with a crowbar. In such a case, is the fulcrum at the point of contact of the crowbar with the ground or with the stone? If the former, in what respect would the action or conditions be changed if one of the rollers had a hole in it, as indicated by dotted lines, and the crowbar was inserted in it and the stone moved in that way. Obviously the friction of the roller on the ground would in that case fulfill the same condition as the resistance of the end of the crowbar did before, and the action would be the

Fig. 6.

same as if a locomotive were moved by taking hold of the tire of a driving wheel and turning it in that way, if it were possible.

Estimating Earthworks.

We have received a letter from "a sub-contractor" inquiring if there is any work published by which he may check the correctness of his estimates. There are several such, which require only a limited knowledge of engineering and mathematics, but we know of none which can be used with any degree of certainty by one without such knowledge and some practice in applying the same. Perhaps the nearest approach to what our correspondent requires would be the tables of "level cuttings" in Trautwine's "Excavation and Embankment," the price of which is $3.00 If he has the notes of the center-heights, he can obtain, in light work, a very approximate result by simply taking from the tables a quantity for each of the center-heights and adding them together; but in experienced hands there is always great uncertainty in any such process, and his safest course will be to employ some competent engineer.

Record of New Railroad Construction.

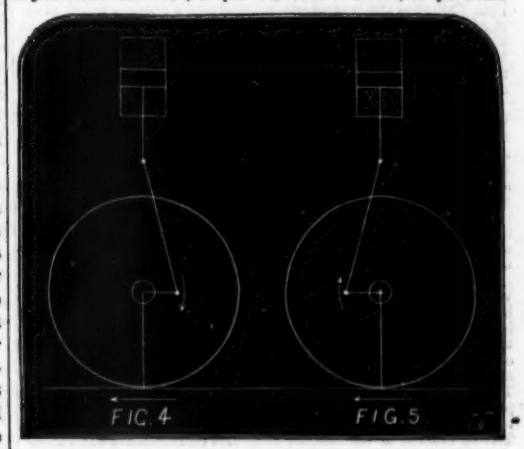
This number of the RAILROAD GAZETTE has information of the laying of track on new railroads as follows:

Utica Ithaca & Elmira.—Track is laid from Spencer northeastward 7 miles to Gridleyville, N. Y. *Easton & Amboy.*—Extended from New Brooklyn eastward 4 miles to Metuchen, N. J. *Toledo & Maumee.*—Completed from Toledo southward 7¼ miles to South Toledo (Maumee City.) It is of 3 feet gauge. *Flint & Pere Marquette.*—Extended from Reed City, Mich., westward 10 miles. *Savannah & Memphis.*—Extended northwestward 2 miles to Kellyton, Ala., 54 miles from Opelika.

This is a total of 30½ miles of new railroad, making 962 miles completed in the United States in 1874, against 2,252 miles reported for the same period in 1873, and 3,962 in 1872.

SIX EAST INDIA RAILROADS, including most of the lines on the Peninsula, with a total average length of 5,465 miles worked, earned during the last half of 1873 at the rate of $2,700 per mile, and their average passenger mileage per mile of road was 123,442, and their average freight mileage 69,667—an extremely light traffic, especially of freight, which is only sufficient for ten American car-loads each way daily. The receipt per train mile was $1.94, the expense $1.08. The average receipt per passenger per mile was 0.756 cent, of which 0.374 was net; the average receipt per ton per mile, 2.28 cents, 0.98 cent being net. The extremely low average passenger rate is accounted by the fact that by far the largest part of the traffic is of the lowest class, and there are no less than five classes of passengers. The first-class rates vary from 2 to 4½ cents per mile; the lowest class, from ⅓ to ¾ cent. Fuel formed 10¼ per cent. of the working expenses and amounted to 27.8 cents. per train mile. The fuels used are native coal, English and Australian coal and wood. The latter is very poor and the foreign coals are very dear, their average cost having been about $11.50 a ton. All these values are given in gold.

THE GRAIN MOVEMENT of the Northwest compares as follows with last year's movement: For the week ending August 22 the six western lake ports with St. Louis and Peoria received 25 per cent. less flour, 20 per cent. more wheat, 65 per cent.



less corn, and nearly the same amount of oats. Altogether, in the bulk of these staples, there was a decrease of about 18 per cent. The great falling off is in corn, of which 2,575,000 bushels were received last year against 1,500,000 this. The heavy wheat movement is in spite of a large decrease in prices, consequent upon the generally good European crops, but it is now reported that farmers are dissatisfied with the prices and are holding back their grain. The corn crop, which, however, will not come to market for several months yet, has been much injured by drouth in a large part of Illinois, which is the chief shipper of grain to market, but how it will compare with last year's crop does not appear. Rain cannot help it now, and its only remaining danger is from an early frost.

Railroad Manufactures.

The works of the Atlantic Car Company at Salem, Mass., were sold at auction recently to Francis Dane, of Hamilton, for $35,650. The company's affairs are being closed up.

The Detroit Car Works at Detroit, Mich., are running with a force of about 175 men.

The sheet iron mill of Seyfert, McManus & Co., at Reading, Pa., was to begin work again last week.

The week before last the Pennsylvania Steel Works at Baldwin, Pa., sent away 1,150 tons of steel rails.

The Rogers Locomotive Works at Paterson, N. J., have now 200 men at work, about one-seventh of a full force, with prospects of an increase in the number soon.

The Danforth Locomotive Works at Paterson have 300 men at work in their machine shop, none of them, however, being on locomotive work.

The Grant Locomotive Works are running with a full force, 800 men. The Russian locomotives are being turned out rapidly.

The Lehigh Car Wheel and Axle Works at Catasauqua, Pa., are running on orders with an average force.

The Brooks Locomotive Works at Dunkirk, N. Y., are gradually increasing the force, and have now about 150 men at work.

The Metric System in our Workshops; Will its Value in Practice be an Equivalent for the Cost of its Introduction?*

BY COLEMAN SELLERS.

In compliance with the invitation of the General Supervisory Committee, as expressed through your Secretary, that, as an associate member of the American Railway Master Mechanics' Association, I should prepare a paper on some subject relating to the objects for which this Association has been organized, I have decided to call your attention to a matter which may before many years be forced upon you, and which you should be prepared to consider with care; I allude to the proposed introduction, by legislative enactment, of the French system of measurement, known as the metric system.

It is not my intention to discuss the subject in all its bear-

ings, for it is a theme requiring more pages of manuscript than I would care to inflict upon you. But I will state in as few words as possible how the proposed change would be likely to affect the workshops of the land. It is now about three-quarters of a century since the metre was first made the legal standard of length in France, and during that time it has been adopted by other countries, either in full or in part; so that the advocates of its universal adoption claim that the proportion of the population of the globe already enlisted in its use numbers 420,000,000. Hence they argue that, for the sake of a uniform metrological system all the world over, England and the United States of America should also adopt it to the exclusion of our present system of inches, feet, etc.

Many of our leading colleges are making the metric system the method of measurement in all their teaching, with a view to sending their graduates into the world as advocates of what to them seems so perfect a system.

There can be no doubt that it is very desirable to have uniformity, not only in regard to measurements of all kind, but also in money, as such uniformity would certainly facilitate trade and advance our knowledge of the works of other countries. Those who use the metric system in all scientific matters find it wonderfully well adapted to facilitate calculation. In spite of its long names it is easily understood by persons of moderate education, and can be used even by those who have no idea of the Latin and Greek words from which the names are derived. If the world, as we know it in our arts and trades, was to be made over again, and we were obliged to adhere to ten as the base of our arithmetic, it would doubtless be a good thing in some respects, but very unhandy in other respects, as not admitting of binary division. I have heard it declared by men of high intelligence that its introduction now is retarded only by prejudice, by the unwillingness of people to give up what they are used to, and the necessity of learning certain new rules and methods of thought. Unfortunately, may be, there is something more than these objections that will retard its introduction. The change involves the expenditure of money—of very large sums of money. When this cost is presented to our minds, we may well consider whether the results to be obtained will warrant the expenditure.

The late Senator Sumner was its earnest advocate, and at one time was determined to push the adoption of the metric system. He said to one of our most distinguished scientists: "I am content to have it legalized in 1870 and to have its use then optional, but in 187– I would make its use compulsory." The gentleman to whom he addressed himself asked if he had well considered what a tax such a measure would impose on the country. "We have now in use," he said, "in all kinds of trades, the pound as our unit of weight, and Messrs. Fairbanks and other scale makers have for years been making platform scales with beams graduated to pounds. The edict that abolishes the pound will necessitate a change in all these machines for weighing. All their beams must be removed and regraduated to the new unit at an enormous expense." He instanced the change in the weight unit as the one most readily made, as it in the main affects perishable property only.

On February 8th, 1870, a resolution was passed in the United States Senate, that "The President be requested, if not incompatible with the public interests, to invite a correspondence with Great Britain and other foreign powers with a view to promote the adoption, by the legislatures of the several powers, of a common unit and standard of an international gold coinage," etc. In accordance with the spirit of this resolution, a dispatch was prepared by the Department of State.* In this paper, after recounting the requirements of such a unification in coinage as shall not prejudicially affect our interests, it says:

"It is to be observed that an identity in the measures of value in the different countries will not completely attain the beneficent results which are sought, unless there be also an identity in weights and measures. * * * In commercial transactions an identity in measures of value would be of comparatively little use if unaccompanied by identity in the measures of the quantities to which those values are applied. There would still be a necessity for the intervention of an expert to shift the expressions of the measures of quantity from the terms used in one country, to those in use in the other. The resolution of the Senate does not contemplate the extension of this correspondence to these points; nor in my judgment would it be desirable to do so.

"It would probably not be difficult to induce the people of different countries to adopt a common standard of weights and measures so far as perishable property is concerned. At first the adoption of unaccustomed systems might cause inconvenience and discontent; but if they should prove to be better than the old ones, and if they should have the further advantage of being common to several countries which possess a common standard of value, and which have extended commercial relations, it is probable that the inconvenience would be patiently submitted to, in view of the greater benefits to be derived from the change.

"But it seems to the Government of the United States that a forced change in the measures of distance, as applied to imperishable property and the permanent investment of capital, may be attended with more serious inconvenience. Thus while it may be practicable to establish a new standard of length-measure for articles of international commerce, such as textile fabrics which are consumed and do not remain, it may be more difficult to make the same change in the standard for permanent values. A few examples will demonstrate the difficulties that would probably attend a change in such measures in this country. * * * *

"It is the custom in the United States to lay out all towns and cities in regular quadrangles, and to divide each quadrangle into an even number of lots with an even number of feet. This has been found a convenient mode of dealing in in town and city lots and in town and city houses. To make an arbitrary change, which should abolish these measures and substitute different ones in their places, involving the use of fractional numbers, would occasion great inconvenience, and might check the dealings in this species of property, and cause a loss to those who happened to be holders at the time of the change. Again, the whole system of titles in those States which have been created out of the public domain rests upon government survey, whose results are expressed in the English mile and its subdivisions, rods, feet and inches. To substitute a different measurement would be a work of serious magnitude.

"Again," and this is what most seriously affects our interests, "the manufactories of the country are filled with machinery, whose delicately adjusted parts, measured in feet, inches and component parts of the inch, work together in one grand whole, which is in its turn combined in the same system of measures. To produce this machinery, thousands of shops are filled with costly plants, adjusted upon the same scale, whose delicate operations often require a nicer determination of measurement than can be obtained without mechanical aid. To transmute these measurements, so delicate and accurate, from the present system into a new one, would appear to be an almost endless labor, if indeed it be a possibility."

To show how clearly these statements express the difficulties that would attend our adoption of the metric system, I will call your attention to certain conditions of the mechanic arts in America, perhaps not fully appreciated by those who think the change is one of education only.

Eli Whitney, whose name has always been associated with the invention of the cotton gin, started, in 1798, an establishment for the manufacture of small arms on the principle known as the interchangeable system, carried out by the use of hardened jigs or forms of the same shape as the parts to be produced, thereby making all parts of guns alike and interchangeable one with another. He introduced the use of milling, by means of revolving cutters, those intricate shapes needed in gun work. When he proposed to Thomas Jefferson, then Secretary of State in Washington's Cabinet, to make an arm modeled after the approved French Charville flint-lock, in which all parts of all guns should be interchangeable, he was ridiculed by both French and English ordnance officers. The government aided Mr. Whitney, and in 1800 the present Springfield Armory was established, and Mr. Whitney's inventions and system put in force there. It was not until 1855 that the English War Department was forced to adopt the same system, importing a large amount of machinery from America for that purpose.

This was not the only branch of the mechanic arts that was benefited by this interchangeable system. America, contending with high labor, has been forced to exercise ingenuity, and make labor-saving machines produce cheaper work. This could only be done by carrying the interchangeable system into other processes of manufacture; and American clocks, watches, sewing machines and all the countless small articles of hardware are made by machinery, each piece like the others. Recognizing the absolute need of this interchangeable quality in everything manufactured, but few trades exist in this country that do not avail themselves of its advantages. Gradually, separate and distinct manufacturing establishments have come to use the same standards and to make their production interchange one part with another. Witness the various devices making up what is known as line shafting, as also all the screws and fittings for steam, gas and water pipes, and now the so complete recognition of the American system of screw-threads for bolts and nuts. The primary object of this Association may almost be said to be to introduce uniformity in all parts of the great railroad system of the United States. There is no country in the world where the value of uniformity in the devices used in common by all mechanics is so fully recognized as in this land of ours. What has been done in this direction, and what is being done now, is founded on the inch as the unit of measurement in the machine shop.

The machine shop, however, is not independent of other trades, and it is necessary to a proper understanding of our subject that we have a clear perception of the nature of this inter-dependence. Machines made of metal have parts cast and parts forged. Wrought iron is procurable in bars of certain merchantable sizes. When rolling mills are obliged to make round iron, differing in diameter from these merchant sizes, the price per pound is increased, as special appliances and extra care are required. So the mechanical engineer conforms his proportions to the procurable sizes of bar iron, and uses the iron, as far as possible, without re-forging into other sizes. This is noticeably the case in regard to rounds and squares. The tools and appliances in the machine shop have in time been made to conform to these sizes, and are all expressed by the division of the inch into halves, quarters, eighths and sixteenths. All the gearing in the country, all the patterns of cog wheels, are spaced in the teeth by pitches measured in inches and the binary division of the inch, ¼ in., ⅛, 1, 1½ in. etc., pitch; or, in number of teeth to the inch in diameter, called in practice per-inch wheels, as 12, 10, 8, or 6 per-inch, meaning so many teeth to each inch in diameter: as, for instance, a wheel three inches in diameter cut to ten per-inch, has thirty teeth, *i. e.*, 10 × 3 = 30. The patterns of gear wheels, in some instances, form no insignificant part of the stock in trade of large machine shops, and the immense number of wheels now spaced to pitches in inches must necessitate the continued use of them, whether we call the pitch 1 in. or 25.38 millimetres.

When the metric system was introduced into France, all machine work was done by hand; the planing machines for metals, and all the various appliances known as machine tools, with the exception of the turning lathe, were almost unknown. Sizes expressed in one measurement or another were of less moment than now. I dare say many of my hearers remember the time when the rule-of-thumb was the mechanic's rule; when the "boss" chalked out on the carpenter's bench a thing about "so big," to be made in metal, and then some other thing was made to fit it; at such time it mattered little what standard was used as measure. While French savants were laboring to build up this decimal system of interchangeable measures, the better class of American mechanics were solving the problem of making machinery with interchangeable parts. I am perfectly willing to concede that there are workshops in the land, in which the change from the inch to the metre could be made at very little cost, simply because these shops are furnished with no special devices for measurement even at this day; such drills and mandrils as they may have are altered in size at the whim and fancy of the workmen. The proprietor of one of this class of shops asked me, not many years ago, if we had a pattern of spur wheel of some pitch and diameter; and when I asked him if he had measured the diameter at pitch line of wheel, he wanted to know what the pitch line meant. Metres would do for that man quite as well as inches. Such machinists, in stating dimensions, use the terms full and scant to express fractions which might be quite readily stated with accuracy; sometimes, however, indulging in the extra expression of a "leetle full scant" for very nice measurement.

A well furnished establishment is provided with gauges, mandrils, reamers, standard drills and boring tools, as well as all other appliances needed for accurate work made to certain fixed sizes, and in most shops these special tools amount in value to large sums of money. The nomenclature of the sizes of these tools, as expressing the work they are expected to do, is part of their economical use; thus, an inch reamer is expected to make a hole exactly one inch in diameter, and no great effort of memory is needed to designate its size; but this same inch reamer will make a hole 25.38 millimetres in diameter—which is the same size expressed in French measurement.

In the machine shop the unit of measurement is the inch, it is not the foot nor the yard; we express in inches all measurements of objects that may sometimes be made less than one foot in size. Thus, pulleys are rated as 5 in. or 10 in. or 72 in. in diameter. Boilers are spoken of as being 36 in., 42 in. or 48 in. diameter. Car wheels are 30, 32 or 36 inches in diameter. For all calculations in the drawing rooms we use the inch and its decimal divisions, corresponding exactly with our dollars and its division into halves: quarters, eighths and sixteenths. As in money we say half a dollar or fifty cents with equal facility, so in measurement we have the half inch or 50 inch, each as expressive of size as the other.

The advocates of the substitution of the metric system for our favorite inch say we have only to give new names to these sizes. This we can do; we can call our inch 25.38 millimetres, or, if we prefer, we can call it the twenty-five hundred and thirty-eight hundred-thousandths of a metre; or we can call it two centimetres, five millimetres and thirty-eight hundredths of a millimetre. They say, further, we can make a slight change in our sizes, and dropping the fractions of the millimetre use the even millimetre; thus our familiar inch would be replaced with the twenty-five millimetre size, which is a decidedly "scant" inch. As an appendix to this paper, I give a list of all our usual fractions of the inch and our even inches up to twelve inches expressed in metric measurement.

Let me now explain how this change of size is to be brought about; that is, what we must do if we are obliged to give up our inch. The drawings of all our machines—drawings that have accumulated through many years, and are expressive of enormous sums of money and the best mechanical talent of the land—must be gone over and all the sizes changed. To express in millimetres the present sizes in inches would never do—it would involve us in a sea of fractions that would drive any ordinary brain crazy. No, we must alter all the sizes in the nearest even millimetres. Thus, some dimensions, marked three inches, must be changed to seventy-six millimetres, .14 of a millimetre smaller than three inches, and some other size must be altered to make up the loss. Think of the labor involved in such a change, and you will not require me to say what such a change will cost. But it is said new work can be made to the new sizes, and the old sizes can be continued for the time. This is exactly the point I wish to reach in the statement of trouble and cost involved.

Drawings made twenty-five years ago are in use to-day, and drawings made during each of the succeeding years are many of them in use, and the tools and gauges are perfected to manufacture machines in accordance with these drawings. To-day we begin new drawings with the new dimensions; the change can be readily made in the drawing room. It requires no vast amount of education to substitute one drawing scale for another. We send the new drawing into the machine shop and then the cost begins; all our old tools of fixed sizes, all our old gauges are wrong; new ones must be made, and we must run the risk of mistakes from the simultaneous use of two standards. Now, for your information, I have taken the trouble to make a careful estimate of the cost involved in altering or making new (for we dare not alter all) the taps, dies, reamers, mandrils, gauges and the other guides for the workmen in an establishment fully equipped for say 250 machinists, and the sum foots up to $27,000—more than one hundred dollars for each man employed. This does not contemplate any change in existing drawings; should we attempt to alter all the drawings, I cannot see how, in the same establishment, the change could be made at a cost less than $150,000. What do you think of such a change at such a cost? Would it not indeed paralyze this industry?

President Barnard, in his very able report in favor of the metric system, or rather in favor of some unification of measurement, says: "I do not expect that this system will make its way in the world against the free will of the people of the world. I do not expect that our people, and I do not desire that any people shall be coerced into receiving it by the force of 'imperial edicts' or by the terror of bayonets. What I do expect is that they will sooner or later welcome it as one of the greatest of social blessings. What I do expect is that they will one day become conscious of the many inconveniences to which they are subjected from the anomalous numerical relations which connect, or rather, we might say, disjoin the several parts of their present absurd system; inconveniences which they have learned to endure without reflecting on their causes or suspecting that they are unnecessary in the nature of things; and that when fully at length awake to the slavery in which they live, they will burst the shackles and rejoice in the deliverance which the metric system brings. This cannot take place, of course, until the people are thoroughly informed."

Business men in all times look at the cost of each change. School men see beauties in the metric system and train their pupils as its earnest advocates, but they do not count the cost. If it is needful to make the change it can be made more cheaply to-day than to-morrow, more cheaply this year than next. While the schools educate the people to see its advantages, the money value of the permanent plant to be changed is increasing more rapidly than the uninformed on this subject can appreciate. Changes in such things as standards of measurement have been made in other countries, and changes, if needful, can be made now; but the question may in all fairness be asked, is it needful in this instance? So far as my own experience goes, having had the opportunity to use the inch and millimetre in one and the same establishment for many years, using one with as much familiarity as the other, my choice is most decidedly in favor of the inch as the unit of measurement in the machine shops and other railroads of the country. That others think so too in regard to one question in mechanics let me prove by an example. Many years ago Mr. Whitworth attempted to establish a uniform system of screw threads based on the inch as its unit. His scheme met with such success that now, with the exception of France only, all the metre-using people of the world have adopted the Whitworth system, and it has even been largely adopted in this country. It is considered better and more convenient than the French system. According to Mr. Whitworth's system a half-inch screw should have twelve threads to the inch; to express this in the metric language, a bolt 12.7 millimetres should be 2.12 millimetres pitch. I have said business men count the cost before making changes in matters of habit or use, but when they can be shown that they will be gainers by the change they give in to it heartily. This same example of screw threads will serve as an illustration. Mr. Whitworth's system of screw-threads was already introduced in all the principal work-shops of Europe and in many in this country. But a better system was presented to the Franklin Institute, a system based on such simple laws that, given the formula with no existing original to copy, any careful workman can originate a given thread that will match those in use. After an exhaustive debate on the subject of its introduction by the various departments of our government, and a careful consideration on the part of our mechanical associations, it came to be adopted as the United States standard. It was adopted at considerable expense because it was believed to be an improvement on existing practice. We have still to keep up our old taps and dies for repair work, but no mechanic has deemed the expenditure involved in the change other than judicious.

To enable you at your leisure to consider the value of our inch unit as compared with the French system, I have added to this paper (Appendix B) a list of some of the prominent metric screw systems as compared with the United States standard and Whitworth.

Recognizing the advantages offered by the decimal system in money, we accept the dollar and cents in preference to the pound sterling of England. We now have in use, in land surveying in the country, the chain and its decimal division. In city measurements the foot and its decimal divisions is also used, and in mechanics we have the inch as our unit, with its division into one hundredths for calculation, and into vulgar fractions where its written expression is rendered plainer thereby. I have in this paper made no attempt to discuss the merits of the metric system as carried out in all its perfection, through measures of distance, surface, solidity and weight. This has been considered by abler men than I am. My object has been to present to you the cost involved in the change, and to show that something more than want of education strengthens the hands of Englishmen and Americans in resisting any change in their methods of measurement. By the law of our land, those of our citizens who choose to use the metric system can do so, and their so doing will meet all requirements of the law; but the standard of the land is, for our purposes, the inch, and I for one should be sorry to see it abolished.

If, as I am informed, some of our schools of science see fit to make their method of teaching dependent on the metre and its division, to the exclusion of the ordinary nomenclature of the land, their wisdom may well be questioned. We need educated engineers, but we need them educated in our mode of thought. The universities of the land are awake to the need of scientific education, and our sons are sent to them

* A paper read at the Chicago Meeting of the American Railway Master Mechanics' Association, May, 1874.

* See United States Report on Foreign Relations for 1870.

that they may learn what will be of the most use to them in active life. We wish them to learn the languages of other leading lands, but we insist that they shall know their own language. We would have them read the scientific languages also, but if for good reasons we choose to retain our technicalities, deeming them more convenient for our use, we also insist that they shall know how to use them in our business relations.

Impressed, as I am, with the insurmountable difficulties in the way of a change in the unit of measurement, even if that change was desirable, I cannot help thinking that, if the hypothetical New Zealander, when he has done contemplating the ruins of St. Paul's, from the sole remaining vestige of London Bridge, in the far-off distance of the future, shall seek from the ruins of a mighty city to learn the nature of a nation's greatness, and shall measure its length and its breadth, as Prof. Piazzi-Smyth the Pyramids, he will find its unit of measurement to have been the inch.

APPENDIX A.

RELATIONS OF THE METRE AND THE INCH.

Millimetres.	Inch.	Inch.	Millimetres.	Millimetres.	Inch.	Inch.	Millimetres.	Inches.	Millimetres.	Centimetres.	Metre.	Inches.
1	.03937			13	.51182			2	50.76	1	.01	.39371
		1-16	1 58	14	.5512					2	.02	.78742
2	.07874					9-16	14.26	3	76.14	3	.03	1.18113
3	.11811			15	.59056					4	.04	1.5748
		1/8	3.17			5/8	15.85	4	101.52	5	.05	1.9685
4	.15748			16	.62994					6	.06	2.3622
		3-16	4.73	17	.65931			5	126.9	7	.07	2.756
5	.19685					11-16	17.43			8	.08	3.1497
6	.23622			18	.70868			6	152.28	9	.09	3.5434
		1/4	6.34	19	.74805							
7	.2756					3/4	19.02	7	177.66			
		5-16	7.92	20	.78742							
8	.31197					13-16	20.60	8	203.44			
9	.35434			21	.82679							
		3/8	9.51	22	.86616			9	228.42			
10	.39371					7/8	22.19					
11	.43308			23	.90553			10	253.80			
		7-16	11.09			15-16	23.77			1	.1	3.9371
12	.47245			24	.9449			11	279.18	2	.2	7.8742
		1/2	12.68	25	.98424					3	.3	11.81 3
						1	25.38	12	304.56	4	.4	15.7484
										5	.5	19.6855
										6	.6	23.6226
										7	.7	27 5596
										8	.8	31.4976
										9	.9	35.4359

1 metre=39.371 in.

APPENDIX D.—COMPARISON OF SCREW THREADS IN USE.

FRANCE.

Pitch in Millimetres.

Diam. in mm.	French Railroads.	Denis Poulot.	Bodmer.	Vignole d'Armengaud. Diam.	Vignole d'Armengaud. Pitch.	Ducommun. Diam.	Ducommun. Pitch.
3	....	....	0.5	....	....	3	0.5
4	....	....	0.5	.. .	....	4	0.75
5	....	....	0.83	5	1.4	5	0.75
6	....	....	0.83	....	. ..	6	1
7	....	1.50	1.00	....	....	7	1.25
8	1.50	1.50	1.00	7.5	1.6	8	1.25
9	....	1.50	1.25	....	....	9	1.5
10	1.5	1.50	1.25	10	1.8	10	1.5
12	1.50	1.75	1.47	....	....	12	1.75
14	....	1.75	1.73	12.	2.0	..	....
15	2.00	2.00	1.73	15	2.2	15	2
18	2.00	2.00	2.00	17.5	2.4	18	2.5
20	2.00	2.50	2.50	20	2.6	20	2.5
23	2.50	2.50	.....	22.5	2.8	23	3.0
24	....	....	2.78	....	....	..	....
25	3.00	3.00	.	25	3.00	25	3.0
26	....	....	2.75	....	....	..	....
28	3.00	3.00	3.125	..	....	28	3
30	3.00	3.50	3.1 5	30	3.4	30	3.5
32	3.00	3.50	3.58	....	....	32	3.5
34	....	....	3.58	....	....	..	....
35	3.50	4.00	. ..	35	3.8	35	4
37	....	....	.....	....	....	37	4
38	3.50	4.00	4.18	....	....	..	....
40	4.00	4.50	....	40	4.2	40	4
42	....	....	4.18	..	....	42	4.5
45	....	....	.....	45	4.6	45	4.5
46	....	....	5 00	...	....	..	....
47	....	....	.....	...	..	47	5
50	....	....	5.00	50	5	50	5

ENGLAND. Whitworth. Diameter in inches.	Diameter in millimetres.	Pitch in millimetres.	No. of threads per inch.	AMERICA. U. S. Standard. Diameter in inches.	Diameter in millimetres.	Pitch in millimetres.	No. of threads per inch.
2-16	4.7	1.058	24	....	....	....	....
1/4	6.4	1.270	20	1/4	6.4	1.270	20
5-16	7.9	1.410	18	5-16	7 9	1.410	18
3/8	9.5	1.585	16	3/8	9.5	1.585	16
7-16	11.1	1.815	14	7-16	11.1	1.815	14
1/2	12.7	2.120	12	1/2	12.7	1.95	13
5/8	15.9	2 309	11	9-16	14.26	2.120	12
				5/8	15.6	2.309	11
3/4	19.1	2.54	10	3/4	19.1	2 54	10
7/8	22 2	2 820	9	7/8	22.2	2.820	9
1	25.4	3.175	8	1	25.4	3.175	8
1 1/8	28.6	3 629	7	1 1/8	28.6	3 629	7
1 1/4	31 8	3.629	7	1 1/4	31.8	3 629	7
1 3/8	34.9	4.225	6	1 3/8	34.9	4.225	6
1 1/2	38.1	4 225	6	1 1/2	38.1	4.225	6
1 5/8	41.3	5.080	5	1 5/8	41 3	4.61	5½
1 3/4	44 5	5 080	5	1 3/4	44.5	5.08	5
1 7/8	47.6	5 650	4½	1 7/8	47.6	5.08	5
2	50.8	5.650	4½	2	50.8	5 650	4½

—Hon. A. H. Morrison has resigned his position as Vice-President and General Manager of the Chicago & Michigan Lake Shore Railroad, on account of failing health. He has been connected with the road from its first commencement. He is succeeded by Mr. George C. Kimball, late of the Flint & Pere Marquette.

Contributions.

Comparing Locomotives with other Steam Engines.

TO THE EDITOR OF THE RAILROAD GAZETTE:

I should like to urge in even stronger terms than I think you have yet used in setting forth the same thing, the importance and the exceeding interest to all steam users of an exact comparison of the work done by the steam machinery of the locomotive with that done by the corresponding machinery of a high class factory engine, or that of a strictly modern steamship.

In the locomotive of the present day, it may fairly be said, is found the result of long and patient effort, in simplifying, rendering more efficient, and reducing the cost of the construction of the whole, considered for the moment only as a piece of steam machinery. It is reasonable, too, to believe that, so far as its adaptation to its peculiar position is concerned and the stringent limits within which it must be kept of size and weight, the locomotive boiler may most justly be compared with the well approved boilers used either in factories or on board ship.

The two elements or factors, then, are given of a well arranged boiler and an equally well arranged engine, both being of a high standard of workmanship in their manufacture, and the question is what is the result obtained in their combined use—the result that is expressed in such terms as will admit of an exact and intelligible comparison with these other forms of steam machinery that have been named.

What is the best that a locomotive will do, or can be made to do, in the evaporation of water?

What is the horse power that can be developed continuously for say half an hour on any tolerably uniform grade or level line?

What is the cost of this horse power in pounds of coal per hour? and this last is the test question that will interest very many of those who know chiefly of steam machinery only in others of these well-approved forms.

The cost of fuel is a leading item in the expense statement of all our roads, and hence, as you have justly urged, the most exact knowledge of the details of this expenditure should be obtained at almost any cost, and also an equally exact knowledge of the work done by the expenditure of the money, or, what is the same thing, by the consumption of the coal.

There is no way in which the efficiency of a locomotive can be so fairly measured, all things considered, as by this method already suggested—measured, that is, for comparison as a piece of steam machinery with other machinery of equally approved design. It is plain that, to effect this measurement, similar means must be used in both cases, and this fact brings in at once, as a necessary element, the careful weighing of coal, its skillful and watchful use, and the application of the indicator to the cylinders—that often recommended but all too little used instrument, the revelations of which are always sure to be full of interest, and often of surprise, even to those who had thought their machinery perfect in its adjustment and operation.

It is true that railroad men are often overburdened, and have no time to give the minute attention that, for a really useful result, must be given to this and to other similar economical considerations, but it is perfectly certain that this is the direction in which at least one of the paths toward improvement leads, and the day will come when he who declined to walk in it will be looked upon as one of the strange things of the past.

P. BARNES.

EDGAR THOMSON STEEL WORKS, PITTSBURGH, August 22, 1874.

General Railroad News.

ELECTIONS AND APPOINTMENTS.

—Mr. C. M. Stanton, General Freight and Ticket Agent, has been appointed Assistant Superintendent of the Springfield & Illinois Southeastern Railroad. Mr. J. S. Beecher has been appointed Train Master in place of J. M. Longstreet, resigned.

—It is reported that Col. Thomas Dodamead, now General Superintendent of the Greenville & Columbia Railroad, has been appointed General Superintendent of the Chesapeake & Ohio in place of Mr. A. H. Perry.

—At the annual meeting of the European & North American Railroad Company in Bangor, Me., August 18, the following directors were elected: G. K. Jewett, M. S. Drummond, T. R. Jones, Arad Thompson, C. P. Stetson, Noah Woods, S. F. Hersey, Bangor, Me.; J. W. Emery, Portsmouth, N. H.; E. B. Burpee, J. R. Ruel, St. John, N. B.; A. Jardine, R. Robinson, W. G. Case.

—The Detroit *Tribune* says: "It is understood that George C. Kimball, formerly of the Flint & Pere Marquette Railway, has accepted the position tendered him some time since as General Superintendent of the Chicago & Michigan Lake Shore road."

—Capt. D. A. Gardner, Jr., for the past two years Depot Master of the Boston, Hartford & Erie Railroad in Boston, has been appointed General Manager of the Norwich & New York Transportation Company, in place of Mr. Julius Webb, resigned.

—At the annual meeting of the Portsmouth & Dover Railroad Company in Portsmouth, N. H., August 12, the following directors were chosen: Frank Jones, Daniel Marcy, F. W. Miller, Wm. Hays, Oliver Wyatt, A. H. Young, A. E. Purinton. At a subsequent meeting Frank Jones was elected President, and Wm. Hackett, Clerk. The road is leased to the Eastern Railroad Company.

—The annual meeting of the Los Angeles & San Pedro Railroad Company was held in Los Angeles, Cal., August 21, and the following directors were elected: Leland Stanford, Charles Crocker, C. P. Huntington, Mark Hopkins, Robert Robinson, L. C. Willcutt, and D. D. Colton. The road is controlled by the owners of the Southern Pacific Company.

—At the annual meeting of the Cincinnati, Rockport & Southwestern Railroad Company in Princeton, Ind., August 25, the following directors were chosen: Clement Doane, H. G. Hannaman, Wm. Hannaman, Aquila Jones, Henry Lewis, S. S. l'Hommedieu, M. N. Moore, John A. Ninn, W. D. Rockwood, F. M. Sabin, S. H. Sabin, Francis Smith, Jacob Zasongood.

—The Belleville & North Hastings Railway Company was organized at Belleville, Ont., August 12, by the election of the following officers: A. F. Wood, President; James Brown, Vice-President; N. B. Falkiner, Solicitor; James Young, Treasurer.

—Mr. Robert Wallace, for some years past foreman of the Susquehanna shops, has been appointed Master Mechanic at Susquehanna, Pa., on the Erie Railway.

—The Indianapolis & Springfield Railroad Company was organized at Indianapolis, Ind., August 26, by the election of the following directors: N. W. Ader, J. Bridges, O. P. Brown, Allen Darnall, W. M. Hess, J. B. Homan, Thomas D. Kingan, John Lee, G. W. McClure, J. M. Nichols, A. K. Starke, W. D. Wiles, J. C. Wright. The board elected John Lee, Crawfordsville, Ind., President and W. M. Hess, Secretary.

—The following new appointments have been made on the Paris & Decatur Railroad: D. Hitchcock, General Superintendent, in place of C. G. Mac; H. W. Hibbard, General Freight Agent, in place of F. C. Stratton; C. E. Follett, General Ticket Agent, in place of D. Brown. The officers are at Terre Haute, Ind. Messrs. Follett and Hibbard hold the same positions on the Vandalia Line, and their appointments indicate close business relations between the two roads. Mr. Hitchcock is Vice-President of the company.

—Mr. Spencer D. Schuyler has been appointed Receiver of the Logansport, Crawfordville & Southwestern Railroad, by the United States Circuit Court, in a foreclosure suit.

—Mr. William A. Dripps has been appointed Superintendent of Machinery of the New York & Oswego Midland Railroad.

—Mr. James Montgomery has been appointed Superintendent of the Clarksville Division of the Louisville & Nashville & Great Southern Railroad, in place of Robert Meeks, transferred to the South & North Alabama Division.

—Mr. J. A. McMurtrie has been appointed Chief Engineer of the Denver & Rio Grande Railway, in place of Howard Schuyler, resigned.

—Mr. W. A. Mills has been appointed General Freight and Ticket Agent of the Columbus & Hocking Valley Railroad, in place of E. A. Buell, resigned.

—Mr. John Crowe has been appointed Auditor *pro tem.* of the Northern Central and Alexandria & Fredericksburg roads, in place of Stephen Little, who has gone to the Erie.

—Mr. D. E. Maxwell, heretofore General Freight and Ticket Agent, has been appointed also Superintendent of the Atlantic, Gulf & West India Transit Company's road, in place of R. H. G. Minty, who has gone to the St. Louis & Southeastern. Mr. Maxwell's office is at Fernandina, Fla.

—Mr. F. H. Gordon has been appointed Auditor of the Wilmington & Weldon Railroad, in place of Charles Flanner.

—Mr. John C. Stillwell has been appointed Cashier and Ticket Agent of the Rome Railroad, with office at Rome, Ga.

—Mr. E. T. Calvert has been appointed Auditor of the Louisville, Paducah & Southwestern Railroad, in place of George D. Sparks, resigned.

—Mr. George D. Sparks has been appointed Auditor of the Louisville, Cincinnati & Lexington Railroad.

TRAFFIC AND EARNINGS.

—The earnings of the Denver & Rio Grande Railway (main line) for the third week in August were: 1874, $8,344; 1873, $8,853; decrease, $509, or 5¾ per cent.

—The earnings of the Burlington, Cedar Rapids & Minnesota Railway for the third week in August were: 1874, $32,267; 1873, $26,231; increase, $6,036, or 23 per cent.

—The shipments of peaches passing through Wilmington, Del., northward, amounted, August 27, to 863 car loads, or 431,500 baskets.

—The earnings and expenses of the Philadelphia & Erie Railroad for July were:

Earnings	$315,615
Expenses (73.75 per cent.)	231,291
Net earnings	$82,324

—The earnings of the Erie Railway for the seven months ending July 31 were: 1874, $10,324,198; 1873, $11,311,700; decrease, $987,502, or 9.58 per cent. The decrease for July was $341,610, making the decrease for the first half of the year $645,892.

—Of the eastward flour and grain shipments from Western lake ports for the week ending September 22, 62 per cent. of the flour, 2¼ per cent. of the wheat, 9¼ per cent. of the corn and 75 per cent. of the oats went by rail.

—The earnings of the Indianapolis, Bloomington & Western Railway for the year ending June 30, 1874, were:

Earnings ($4,805 per mile)	$1,673,309 08
Expenses (56.31 per cent.)	941,690 65
Net earnings ($2,099 per mile)	$730,618 43

—The shipments from the Lake Superior iron region from the opening of navigation up to August 27 were as follows:

	Iron ore. tons.	Pig iron.
From Marquette	285,273	17,216
" Escanaba	172,986	8,623
" L'Anse	58 209	4,835
Total	517,467	30,674

—The earnings of the Great Western Railway of Canada for the week ending August 14 were: 1874, £18,303; 1873, £20,775; decrease, £2,472, or 11¾ per cent.

—The earnings of the Grand Trunk Railway for the week ending August 15 were: 1874, £40,100; 1873, £39,600; increase, £500, or 1¼ per cent.

—The receipts of grain and flour at Baltimore during August were as follows:

	1874.	1873.
Grain, bushels	1,851,849	1,159, 631
Flour, bushels	184,805	120, 988

The increase in grain this year is 692,218 bushels, or 60 per cent.; in flour, 63,817 barrels, or 52¾ per cent.

PERSONAL.

—Mr. W. H. Hipple has resigned his position as Master Mechanic of the Texas & Pacific Railroad, and has gone East.

—Gen. Hugh T. Reid, who was one of the original builders of the Des Moines Valley Railroad, and President of the company for some years, died in Keokuk, Ia., August 21.

—Mr. George T. Benedict, General Manager of the Cincinnati, Sandusky & Cleveland road, died at St. Albans, Vt., August 22. Mr. Benedict was for several years on the Vermont Central, was subsequently Assistant Superintendent of the New Orleans, Mobile & Texas, and Superintendent of the New London Northern, which road he left two years ago to take his last position. He had been sick for some time and was visiting St. Albans for the benefit of his health when he died.

—Conductor Ward Nichols has completed 25 years in the service of the New York, New Haven & Hartford Railroad Company. He is the oldest conductor on the road.

—The Leavenworth (Kan.) *Times* says: "General Superin-

endent E. S. Bowen, of the Kansas Pacific, has resigned, for the purpose, it is said, of accepting a position on the Erie road. Mr. Bowen was one of the best, most successful and popular railroad men in the West, and the people of this portion of the country will learn with regret of his proposed change of base."

—Mr. David Holz has resigned his position as Supervisor of Cars on the Erie Railway.

—Mr. Benjamin F. White, for many years a director of the Boston & Worcester Railroad Company, died at his residence in Boston, Mass., August 25. He was the only survivor of the original board of directors of the Boston & Worcester.

—Mr. M. W. Goss, General Freight Agent of the Chesapeake & Ohio road, has resigned. It is reported that Mr. A. H. Perry has also resigned his position as General Superintendent of the road.

—Col. J. C. Sprigg has resigned his position as Superintendent of the Petersburg Railroad, to take charge of another line.

OLD AND NEW ROADS.

South Side of Long Island.

It is said that parties acting in the interest of the Flushing, North Side & Central Company have secured control of a large part of the first-mortgage bonds, and that they propose to buy the road at the coming sale, reorganize the company and work the road in the interest of the Flushing Company. It is also reported that the Long Island Railroad Company is endeavoring to secure the road, and that a third party, mainly composed of the original proprietors, is also desirous of getting control.

Baltimore & Ohio.

The Baltimore & Potomac Company has given notice that on and after September coupons of tickets reading over the Baltimore & Potomac Railroad and accepted for passage by the Baltimore & Ohio Railroad Company will not be redeemed by the Baltimore & Potomac Railroad Company. Passengers will be required to take passage on the trains of the road over which they are ticketed. This action was taken without consultation with or previous notice to the Baltimore & Ohio.

The great shops at Newark, O., the junction of the Central Ohio, Lake Erie and Straitsville divisions, are approaching completion. The store-house and office building, 100x50 ft., is finished. The boiler shop in process of construction is 70x180 ft. The blacksmith shop, already completed, is also 70x180 ft. The foundry, 200x70 ft., is in operation and considerable work is being turned out. The car shop, completed but not yet in operation, is 75 ft. in the clear and 230 ft. in diameter, attached to which is a 55 ft. turn-table. The woodworking machine building, two stories, is a fine structure 200 ft. long by 70 ft. wide, connected to which is a fire-proof engine room and glue room. The locomotive shop is 275 ft. in diameter and 70 ft. in the clear, with 30 stalls. All the buildings are substantially built of brick, covering with the yards an area of 22 acres.

Utica, Ithaca & Elmira.

This company now runs its trains over the Geneva, Ithaca & Athens road from Ithaca to Van Ettenville, which arrangement, however, is only temporary. During this season the company has completed an extension of about seven miles, from Spencer northeast to Gridleyville on the Ithaca & Owego. From that point to Pugsley's the road will run parallel with the Ithaca & Owego track. At Pugley's the old Murdock grade is struck and will be followed to Ithaca, connecting with the Ithaca & Cortland Division on University Hill.

It has been proposed to run over the Midland's Western Extension from Cortland to De Ruyter, from which point only 20 miles of road will have to be built to reach the Utica, Clinton & Binghamton at Smith's Valley, thus completing a pretty direct line from Utica to Elmira.

St. Louis Union Depot.

The temporary union depot in St. Louis is making rapid progress. The tracks from the tunnel are all laid, the tracks in the depot itself are ready and the the platforms and waiting rooms commenced.

Joliet Iron and Steel Works.

It is believed that an arrangement has been concluded with the creditors under which work can be resumed in a short time. Mr. John G. Scott, of St. Louis, has been chosen President of the company, at a meeting at which very nearly all the creditors were represented.

The Master Car Painters' Association.

The fifth annual meeting of this association commenced in Buffalo, N. Y., September 2, delegates being present from seven States, and others being expected.

Union Pacific.

Notice is given that the time for exchanging the income bonds for the new sinking-fund bonds is extended until September 15. Officers of the company state that nearly all of the income bonds have been exchanged, those still outstanding being mainly in the hands of small holders.

United States Contracts.

Major Wm. P. Craighill will receive at his office, Union Bank Building, Fayette street, Baltimore, Md., until September 19, proposals for dredging in James River.

Major G. Weitzell will receive, at his office, No. 85 Washington street, Detroit, Mich., until October 1, sealed proposals for the stone for the St. Mary's Falls Canal improvements.

Philadelphia & Reading.

The Philadelphia *Railroad and Mining Register* says:

"The iron ship building works of the company on the Delaware, at Port Richmond, are now approaching completion. They include blacksmith, tool, boiler and joiner shops, and it is calculated that four iron ships can be built by the company at one time when the works are in full operation. The buildings cover a considerable area, and the most approved machinery for the making of iron vessels has been provided.

"The blacksmith shop, which is of brick, one story in height, will have places for eighteen fires, and be provided with a large steam hammer. The tool shop is a very large one-story building, with a lantern roof. It is fitted up with furnaces and valuable machinery for preparing the metal and manipulating it into the ribs, plates and other pieces used in the construction of iron vessels. A large steam engine is also in the building. Adjoining the tool shop is the boiler shop, which has a steam machine for riveting boilers. On the side nearest to Richmond, and parallel with the tool shop, is the joiner shop, a two-story brick building, the mould loft being in the second story.

"The mold loft is very spacious, having sufficient room to admit of full sized plans of the different parts of the boats to be constructed. Ship ways, large enough for the construction of four ships, are being built, and about half of the ways have been completed. It is also proposed to build a large dry dock for the repair of vessels. The ground on which the buildings have been erected was formerly very low and swampy, and previous to the commencement of the buildings, a large amount of filling in had to be done, and a considerable number of piles to be driven to secure a firm foundation. The grading was commenced in May, 1873, and the buildings in September last.

"Considerable progress has been made in the construction of the bridge across Richmond street, and a portion which was completed some time since has been used by the railroad. The bridge is of iron, with one span, and has granite abutments. The railroad company are constructing the bridge, and the city pays a sum estimated at one half of the expense to be incurred in its erection."

Indianapolis, Bloomington & Western.

This company has issued a second circular to the Extension and second-mortgage bondholders, which contains nothing new, except a statement of the earnings of the road for the year ending June 30, from which it appears that the net earnings were $730,618.43. It repeats the proposal that bondholders should fund five coupons (July 1, 1874, to July 1, 1876, both inclusive,) in 7 per cent. certificates of indebtedness, payable July 1, 1881, the coupons to be deposited as security with a trustee. As in the former circular, a somewhat vague explanation of the default is given by the statement that the net earnings were used for building of sidings and purchase of equipment, which, it was expected, would be paid for by the sale of bonds. The negotiation of these bonds, however, failed. No definite statement is given of the actual sums expended.

Joliet & Northern Indiana.

The first-mortgage 8 per cent. bonds of this road, which amount to $800,000, came to maturity in July last and have not yet been paid. The road is leased at a fixed rental of $2,000 per mile by the Michigan Central Company, which also owns 2,243 shares of stock out of 3,000. Under the lease the lessee is under no obligation to provide for the principal of the bonds; the interest has always been promptly paid out of the rental and also 8 per cent. dividends on the stock. The Michigan Central Company, however, as holder of the controlling interest in the stock, now offers to exchange for these over-due bonds new 6 per cent. bonds having 20 years to run, and to quiet the other stockholders offers to give 6 per cent. bonds for their 757 shares of stock also. The bondholders, however, object to taking a 6 per cent. in place of an 8 per cent. bond, and claim that one of the stipulations of the mortgage is that 8 per cent. interest shall be paid until the principal is paid It is possible that the case will be taken into the courts.

Nashua & Plaistow.

The late New Hampshire Legislature chartered this company to build a road from Nashua, N. H., eastward to the Boston & Maine in Plaistow, a distance of about 20 miles. The capital stock is to be $1,000,000.

Springfield & Northwestern.

It is reported that tracklaying has been begun on the 11-mile gap between Springfield, Ill., and Central.

Cobourg, Peterboro & Marmora.

This company has voted to apply to the Ontario Legislature for authority to increase the capital stock, for the purpose of extending the road to Mud Lake.

Port Royal.

The courts having refused to compel the State Treasurer of South Carolina to receive in payment of tax bills of the State Bank, which were tendered by this company, the State Auditor has directed proceedings to be taken at once to levy on the property and enforce the payment of the taxes.

Philadelphia & Reading.

The steam collier "Pottsville," the sixth vessel of her class owned by the company, was launched at Philadelphia, August 26, from the yard of Cramp & Sons. The ship is 250 feet long, 37 feet beam, and 20 feet depth of hold, with a carrying capacity of 1,500 tons of coal. Her engine has a surface condenser, 42 inches square. The propeller is 12 feet diameter and 17 feet 6 inches pitch, the blades bolted to the hub.

Green Bay & Minnesota.

The elevator, wharf and freight house at East Winona, Wis., are completed and ready for use. The elevator is 50 by 80 feet, and has a storage capacity of 120,000 bushels. The wharf has a frontage on the Mississippi of 550 feet, and has on it a freight house 57 by 250 feet.

Roanoke Valley.

The delay in completing the line from Clarksville, Va., north to Keepville on the Richmond & Danville has given rise to some talk of rebuilding the old road from Clarksville east to Manson Junction on the Raleigh & Gaston. The latter company will, it is said, do the work if it receives stock subscriptions to the amount of $125,000.

New York, Norfolk & Eastern Shore.

The counties of Accomac and Northampton, Va., will hold elections, September 12, to decide whether they shall subscribe enough to purchase the right of way from Cherrystone to the Maryland line. It has been decided to connect with the Delaware system of roads at Snow Hill, Md., the southern terminus of the Worcester Railroad.

Penn Gas Coal Company.

This company has nearly completed a railroad about 10 miles long, from the Pennsylvania at Irwin's, Pa., south by west to the Youghiogheny River and the Pittsburgh, Washington & Baltimore Railroad at the mouth of the Big Sewickley. The arching of the summit tunnel, 600 feet long, is being finished, and it is thought the road will be finished by November.

Chestnut Ridge.

Arrangements are being made to build a railroad some six miles long from the Chestnut Ridge ore banks in Fayette County, Pa., west to the Mount Pleasant & Broad Ford road near Iron Bridge.

Meetings.

The semi-annual meeting of the General Passenger and Ticket Agents' Association will be held at the St. Nicholas Hotel, New York, September 18.

The annual meeting of the Indianapolis, Bloomington & Western Railway Company will be held at Urbana, Ill., September 9.

Dividends.

Dividends have been declared by the following companies:

Lehigh Coal & Navigation, 2 per cent., quarterly, payable September 10.

Southwest Pennsylvania, 3 per cent., payable October 1.

Texas & Pacific.

Tracklaying is actually in progress from Dallas, Tex., westward towards Fort Worth.

All through freight is now transferred between this road and the St. Louis, Iron Mountain & Southern without breaking bulk, the car trucks being changed at Texarkana to accommodate the change of gauge.

The Marshall shops are turning out four freight cars per week.

Delaware River & Bound Brook.

Contracts for the grading and masonry of the 27 miles of road from Bound Brook, N. J., to the Delaware near Yardleyville, are to be let shortly.

Des Moines & Fort Dodge.

Those bondholders of the old Des Moines Valley road, who now own the northern section, met in New York, September 1. It is understood that the meeting was held to consider the question of the distribution of the equipment of the old road between the two new companies, the Des Moines and Fort Dodge and the Keokuk & Des Moines, about which there has been some trouble. After a long discussion, the meeting adjourned to September 4, without taking any action.

Chester & Lenoir.

The route of this road is from Chester, S. C., northward through York, Dallas, N. C., and Lincolnton to Newton and thence northwest through Hickory to Lenoir, in all a distance about 110 miles. The company has in operation the 23 miles from Chester to York, which was formerly known as the King's Mountain Railroad, and contracts have been let for the grading and trestle-work of 55 miles more, which is to be finished by February 1, 1875. The road will be of 3-feet gauge.

Trafalgar & Nashville.

A line has been surveyed for a railroad from Nashville, Ind., north by east to Trafalgar on the Cincinnati & Martinsville Railroad, a distance of about 15 miles.

Louisville, Paducah & Southwestern.

The Lower Board of the Louisville General Council has voted a city subscription of $1,000,000 to the stock of this company, in whose road the city has already invested $1,000,000. This subscription, if finally made, will enable the company to purchase much-needed equipment and pay off pressing debts.

Poughkeepsie & Eastern.

A meeting of the first-mortgage bondholders was held in Poughkeepsie, N. Y., August 29. A report was submitted recommending a foreclosure and a reorganization of the company. Without taking final action an adjournment was had to September 15.

Carolina Central.

Regular trains began running to Beaver Dam, N. C., the new terminus, August 27. Tracklaying is progressing steadily beyond that point.

Chicago & Michigan Lake Shore.

The interest due on the $477,000 8 per cent. bonds of 1889 September 1, was paid on that day.

Connecticut Western.

Arrangements are being made to put on an express train from Hartford to Albany over this road, the Rhinebeck & Connecticut and the Hudson River, as soon as the Rhinebeck road is ready.

A new track is to be built at once through the village of Winsted, Conn., where the track of the Naugatuck road is now used.

Albany & Susquehanna.

It is stated that the lessee, the Delaware & Hudson Canal Company, has resolved to change the gauge of this road from 6 feet to the standard 4 feet 8½ inches, and that the change will be made very soon.

Ware River.

In the suit brought by this company against Vibbard, Foote & Co., of New York, to secure possession of 800 tons of rails, the Massachusetts Supreme Court has decided for the defendant. The rails were sold to Smith & Co., contractors for the road, and the company claims to have paid them; but the Court decided that Vibbard, Foote & Co. had a vendor's lien on the iron and had the right to hold it until that lien was satisfied, when the insolvency of the contractors and the company was disclosed.

Hoosac Tunnel Line.

The companies interested are urging that one track at least should be laid through the tunnel at once, so that freight trains may begin running through. The principal objection is that the passage of trains will hinder the work of arching the roof.

A block of granite weighing 14 tons has been brought from the Norfolk (Conn.) quarries and will be set up over the west entrance as part of the facade.

Norwich & Worcester.

At a special meeting at Worcester, Mass., August 20, the stockholders of this company voted to authorize the issue of $1,000,000 new stock, the proceeds of which are to be used to pay for the viaduct and depot changes at Worcester, the extension of the road from Allyn's Point, Conn., to Groton, a new bridge at Norwich and other improvements. By the last report the stock was $2,823,400, which the new issue will bring up to $3,823,400, or $57,581 per mile. The bonded debt is $734,000, or $11,054 per mile. The road is operated by the Boston, Hartford & Erie trustees at a rental of 10 per cent. on the stock. The lessees will, it is stated, pay the same dividends on the new stock as on the old. The new stock is to be issued from time to time as the board deems advisable and will be sold at auction in Boston.

The rental paid for the use of the New London Northern road from Norwich to New London, 13 miles, is $42,000 ($3,230 per mile), and it is to avoid this heavy charge that the company intends to build the six-mile extension from Allyn's Point to deep water at Groton, the interest on which will be much less than the present cost of getting to New London.

Belleville & North Hastings.

This road is intended to connect the iron mines of Madoc and Pardee, Ont., with the Grand Junction Railway, now under construction, near Stirling. A considerable portion of the stock has been subscribed, and the company organized.

Portsmouth & Dover.

The stockholders at the recent annual meeting voted to accept the act of the Legislature authorizing the increase of the stock by $100,000, which will make it $800,000, or $74,766 per mile.

Indianapolis & Springfield.

A company by this name was organized at Indianapolis, August 26, to build a railroad from that city nearly due west, through Danville, Bainbridge and Rockville to Montezuma, the eastern terminus of the Indiana & Illinois Central. The road would be about 66 miles long, and the capital stock is to be $2,000,000. This is a part of the route of the Indiana & Illinois Central, on which it would have completed its line this year if affairs had been prosperous.

Great Western of Canada.

A telegram from London, Eng., says that at the stockholders' meeting, August 26, the old board retired without a contest, the Investigating Committee having secured 75,000 shares against 42,000 for the old management. The report of the Investigating Committee was adopted. An entire change in the Canadian management is expected, and also the abolition of the Canadian board of directors. The meeting adjourned to September 9, when a new board of directors will be elected.

A telegram from London states that the answer of the directors to the report of the Great Western of Canada to the report of the Investigating Committee has been issued. The directors review in detail the committee's report and protest that they have always honestly labored for the best interests of the company. The severe winter of 1872–73, and the increase in the price paid for labor and materials they could not control. They did all that was possible to ward off the construction of competing lines. The road is at present suffer-

ing from the effects of the panic of last fall, and the directors believe that when the present depression passes away, the money which has been expended will yield a fair return.

St. Louis & Southeastern.

President Winslow publishes in the Frankfort papers an address to the German bondholders, in which he says that on consultation with the Dutch bondholders at Amsterdam he found that they were unwilling to come to any agreement until after they have received a report from an expert in American railroad property whom they have employed to inspect the company's property and ascertain the method of its expenditures of capital. After that they propose to make some arrangement in America, the leading features of which will be that the first-mortgage bondholders shall have control of the management, mainly so far as receipts and expenditures are concerned; the surplus earnings of the St. Louis Division to be devoted first to its first-mortgage interest, they taking precedence of the consolidated mortgage bonds.

Under these circumstances General Winslow determined to return to America immediately, give the representatives of the Dutch bondholders all possible aid, and endeavor to prepare in connection with them and the other creditors a definite plan for a settlement, which will then be submitted to the bondholders.

California Pacific.

The Frankfort Committee of California Pacific Extension bondholders advertises that it has resolved to commence legal proceedings against this company to compel it to fulfill its guarantee on the Extension bonds, and invites holders to send in their bonds and authorizations. H. Seligman, of the firm of Seligman & Stettheimer, is President of this committee, and Dr. K. Wagner Secretary.

Kansas Pacific.

This company has announced in Germany that a majority of the holders of the 7 per cent. Kansas Pacific and the 6 per cent. Eastern Division bonds have already accepted the proposition for funding their coupons. The Stuttgart Committee for the protection of the Eastern Division bondholders announce in reply that they have not entertained this proposition for funding, and prefer to secure the rights of the bondholders by process of law.

Savannah & Memphis.

Trains are now running to Kellyton, Ala., two miles beyond the late terminus and 54 miles northwest from Opelika.

Erie.

An order has been issued for a reduction of 10 per cent. in the salaries of all employes who receive over $1.50 per day.

It is stated that many of the subscribers to the $15,000,000 consolidated bonds negotiated in London some weeks since withdrew their subscriptions, leaving a large amount on the company's hands. Mr. J. A. C. Gray, one of the new directors and a member of the Finance Committee, has been in London, and, it is reported, has succeeded in placing the bonds thus thrown back upon the company.

At the regular monthly meeting of the board of directors, August 27, the board confirmed the arrangement recently made between the trunk lines in reference to the abolition of ticket offices, and also to increased rates of fares and freight. A report was made in favor of moving the general offices in New York from their present location in the Grand Opera House building to the old Erie building at Duane and West streets.

The Second Vice-President with other officers is now making a trip over the road on the plan laid down some time since. A stop is made at each station, complaints listened to, and a conference held with the business men of that place with a view to affording all needed accommodations for business. At latest dates the party was at Buffalo, where a stop of several days was to be made.

The old round-house and shops at Piermont, N. Y., were destroyed by fire August 20. These were formerly the main shops of the company and were quite extensive, but they were abandoned some years ago. The tools were nearly all removed and the shops were empty and gradually falling into decay.

Logansport, Crawfordsville & Southwestern.

The United States Circuit Court at Indianapolis, August 27, appointed Spencer D. Schuyler Receiver of this road, on application of the Farmers' Loan and Trust Company, trustee for the bondholders. The trustee also filed a bill of foreclosure of mortgage. This action is taken to protect the interest of the bondholders against the other creditors, who are obtaining judgments and seek to enforce them.

Alabama & Chattanooga.

The United States Circuit Court has issued an order removing the present receivers, A. Murdock and A. Foster Elliott, and placing the road in the hands of the trustees under the first mortgage. The Court also postpones the foreclosure sale until after the next meeting of the Court, and removes the limit of price on the sale, thus permitting the boadholders to obtain the best price possible. The order of the Court also authorizes the trustees to purchase the property for the protection of the bondholders in case it becomes necessary, subject to the receivers' certificates and Court charges, which are a prior lien to the bonds, and also that the bids of the trustees shall inure to the benefit of the holders of the first-mortgage bonds, who shall surrender their bonds to the trustees for the purchase of the road.

South Side, of Long Island.

The foreclosure sale, which was to have taken place August 31, has been adjourned to September 9.

The trustees under the first mortgage advertise that the coupons on the first-mortgage bonds which became due March 1, 1874, will be paid at the Atlantic Bank, Brooklyn, N. Y., after September 1.

Chesapeake & Ohio.

Suit has been brought in the New York Supreme Court to have the trustees under the first mortgage removed, on the ground that they have refused to act at the request of bondholders, and to enforce the terms of the mortgage, Wm. Butler Duncan, one of the trustees, appeared by counsel and asked an adjournment until Mr. Calhoun, the other trustee, could return from Europe. Exception was taken to the jurisdiction of the Court, but overruled, and the case adjourned to the September term.

Cumberland & Ohio.

A contract has been closed for the iron to lay 31 miles of the road, from Lebanon, Ky., south by west to Greensburg, that section being already graded and the ties ready. The first lot of rails is already at Lebanon.

Flint & Pere Marquette.

Rails are laid from Reed City, Mich., westward 10 miles on the extension to Ludington, leaving 30 miles yet to be laid. Tracklaying has been somewhat delayed by the non-arrival of rails.

Easton & Amboy.

The track is laid to the crossing of the Pennsylvania road at Metuchin, N. J., 11 miles from Bound Brook and four miles beyond the late terminus at New Brooklyn. About six miles remains to be laid to carry the road to the eastern terminus at Perth Amboy, and work is progressing steadily.

On the western end track is being laid from Phillipsburg eastward and construction trains will soon be at work. It seems probable that the bulk of the work will be completed this fall, and, if the Pattenburg Tunnel progresses well, the road will be open next spring.

Paris & Danville.

It is stated that Mr. Short, President of this company, has succeeded in negotiating in New York bonds enough to purchase 4,000 tons of rails to be used on the extension of the road southward to the crossing of the Ohio & Mississippi road, near the Wabash River.

Laurens.

The District Court confirmed the sale of this road in bankruptcy, August 10. The purchaser was the South Carolina Railroad Company. An appeal was taken, which will come up before the Circuit Court at Columbia, S. C., at the November term.

The road is 32 miles long, from the Greenville & Columbia road at Newberry, S. C., northwest to Laurensville. We believe that it has not been operated since the war.

Missalonskee & Kennebec.

The corporators of this company met in Augusta, Me., August 31, and, after voting to accept the charter, organized by electing a board of directors. The charter, which was granted by the last Maine Legislature, provides for a railroad from Augusta, Me., northward about 20 miles to West Waterville. It is designed as a southern extension of the Somerset road.

Painesville & Youngstown.

Passenger trains commenced running over the whole length of the road, from Painesville, O., to Niles, 50 miles, August 31.

Toledo & Maumee.

The rails are all laid on this line from Toledo, O., to South Toledo (Maumee City) and the only work still to be done is the surfacing and ballasting. Trains have been running over the road, which is 7½ miles long, since August 16, and are reported as doing a good business. The present equipment is on locomotive, built by Porter, Bell & Co., one passengar car, one box and two flat cars, the latter being used as observation or excursion cars. The cars were built by the Litchfield (Ill.) Car Company. The road is of 3 feet gauge.

Central, of New Jersey.

The dispute as to the opening of certain streets in the City of Newark, N. J., under the track of the Newark & New York Branch has been ended by the company giving way. Its counsel has notified the city authorities that bridges will be put up at once at the points indicated by the City Council.

This company has decided to make a consolidated mortgage covering all its property to secure an issue of bonds not to exceed $25,000,000. Of this amount there will be reserved sufficient for the conversion by exchange of the existing $5,000,000 first-mortgage bonds, $600,000 Newark & New York bonds assumed, $175,000 bonds due in 1875, and as many of the $5,000,000 convertible bonds as may not be exchanged for stock by 1875. The remainder of the new bonds will be issued from time to time, as the necessities of the company may require. The new bonds will be dated September 1, 1874, will bear 7 per cent. interest, payable quarterly, and will have 25 years to run. An immediate issue of $5,000,000 is to be made to cancel certain outstanding debts and to complete improvements now in progress or projected. This issue is, for the present, offered to stockholders alone at an issue price of 90 per cent.

The payments to be made from the proceeds of this issue are: for coal interests, $1,000,000; steel rails for main line, $750,000; new shops, $500,000; new coal wharves at Port Johnston, $400,000; new station-houses, new tracks and filling Bay Bridge, $250,000; improvements at Communipaw and payment to State of New Jersey for riparian rights, $600,000; new branches and second track on Lehigh Division, $500,000; new equipment, $500,000; total, $4,500,000.

For the year 1873, after paying interest, rentals and 8 per cent. dividends, there was a surplus of $977,328.41.

Delaware, Lackawanna & Western.

The passenger trains of the Utica Division and the main line are being supplied with the Westinghouse air brake.

Pennsylvania—Amboy Division.

The men and tools from the car repair shops at Bordentown, N. J., are being removed to the new shops on the Hackensack meadows, and the Bordentown shops will soon be finally closed and deserted.

New York & Canada.

Over 400 men are at work between Mullen Brook and Port Kent. The Willsboro tunnel is well started, a heading of 70 feet having been made at the north end and one of 35 feet at the other. The work of building the depots has commenced on the southern end of the road.

Portland & Ogdensburgh.

All the available force is now employed on the heavy work through the Notch in the White Mountains, between Bemis' and the Fabyan Place. It is hoped that this section can be completed by early spring, when the work from Fabyan Place to a connection with the Vermont Division can be quickly done, as it is comparatively light.

Cayuga Lake.

This road was sold under order of the Court, August 27, by the referee, P. G. Clark, of Auburn, N. Y. It was purchased by James Stillman, of New York, on behalf of the second-mortgage bondholders, for $1,205,000, which probably includes the first mortgage of $800,000. The second-mortgage bonds amounted to $460,000. The road is 38 miles long, from Cayuga, N. Y., south by east to Ithaca.

New York & Oswego Midland.

The first-mortgage bondholders met in New York, August 28, to receive the report of the committee appointed to prepare a plan for reorganization. The committee presented the following as the essential points of its plan:

First—That the control and management of the railroad shall be left in the hands of the first-mortgage bondholders until the regular payment of interest upon their bonds is secured.

Second—That holders of the present first-mortgage bonds and receivers' certificates should have new first-mortgage bonds, which shall bear coupons from as early a date as can be justified by reasonable expectation of sufficient net earnings for that purpose.

Third—That before the property is thus mortgaged, there shall be raised upon it such cash funds as may be needed for putting the railroad in good order and repair, and for defraying such cash expenditures as cannot be avoided upon the reorganization.

Fourth—That all junior securities, floating debt and stock, shall have consideration in the exact order of their respective priorities, upon equitable terms, and that the holders of such junior securities shall have the right by committees of their number to arrange details of same with your representatives.

Fifth—That as a condition of the recognition of junior securities upon the reorganization, the holders of such securities shall be required to raise in part the funds indicated under the third point.

Sixth—That for the purposes of a reorganization the Western Extension be regarded as a later and separate undertaking on the part of the railroad company, having no relation to our first mortgage, but that there should be some recognition among junior securities of the fact that nearly all of the proceeds of the Western Extension bonds were used for the completion and operation of the main line.

The details of this plan to be arranged by competent legal counsel.

After a long discussion, this plan was adopted and the committee continued, with power to appoint five trustees to carry out the plan and aid in the reorganization.

ANNUAL REPORTS.

Huntingdon & Broad Top.

This company owns a road 44 miles long from Huntington, Pa., southward to Mt. Dallas, with three coal branches: Shoup's Run, 9¼ miles; Six Mile Run, 4½ miles; Sandy Run, 1¼ miles, making a total of 59 miles. The Sandy Run Branch is to be extended some three miles this year.

The property is represented as follows:

Preferred stock	$940,000
Common stock	930,000
Total stock ($31,695 per mile)	$1,870,000
Bonded debt ($36,636 per mile)	2,161,500
Scrip outstanding ($2,327 per mile)	137,344
Total ($70,658 per mile)	$4,168,844

The earnings for the year ending December 31 were as follows:

	1873.	1872.
Earnings	$431,107 47	$310,952 54
Expenses	241,102 92	187,118 34
Net earnings	$190,004 55	$123,834 20
Earnings per mile	$7,307	$5,293
Per cent. of expenses	66.44	60.35

The increase in earnings was 39 per cent.; in expenses, 28⅞ per cent., and in net earnings, 53½ per cent. The work done was as follows:

	1873.	1872.
Passengers carried	71,869	59,1 6
Tons coal carried	474,178	318,372
Tons ore and limestone	98,080	97,0 1
Tons pig and other iron	16,305	17,094
Tons general freight	28,674	17,281
Total tonnage	617,237	449,748

The increase in tonnage was about 35 per cent.

During the year $281,467.78 was expended in new construction and equipment. These expenses have been met mainly by temporary loans, sales of stock, and bills payable.

Atlanta & West Point.

This company operates a road 87 miles long, from Atlanta, Ga., southwest to West Point. Of this the use of six miles (Atlanta to East Point) is leased from the Central Railroad Company of Georgia at a rental of $6,000 per year.

The company's capital account is a remarkably light one, the property owned being represented only by the following securities:

Stock ($15,212 per mile)	$1,232,200
Bonds ($1,265 per mile)	102,500
Total ($16,477 per mile)	$1,334,700

The earnings and expenses for the year ending June 30 were as follows:

	1874.	1873.
Passengers	$111,717 74	$142,068 41
Freight	185,740 21	235,208 38
Mails and other sources	26,635 29	22,067 51
Total earnings	$324,093 24	$399,344 30
Operating expenses	212,079 05	299,182 86
Net earnings	$112,014 19	$100,161 44
Earnings per mile	$3,725	$4 590
Per cent. of expenses	65.44	74.92

The decrease in earnings is $75,251.06, or 18.84 per cent.; in expenses, $87,103.81, or 29.11 per cent.; the increase in net earnings, $11,852.75, or 11.83 per cent. During the year 48,702 bales through cotton and 41,454 bales local cotton were carried, a total of 90,156 bales, being an increase of 5,983 bales over the preceding year.

Four miles of new iron have been laid during the year, and as much more is needed the current year. There is urgent need of a new depot in Atlanta.

United States Rolling Stock Company.

The report of the General Manager for the year 1873 gives the following statements:

Rentals:	
From locomotives	$153,364
From passenger train cars	76,518
From freight train cars	776,706
Total rentals	$1,006,648
Interest	46,483
Balance from last year	26,652
Total receipts	$1,079,783
Operating expenses, freights, repairs, etc	66,058
General expenses	37,587
Estimated loss by doubtful debtors	20,604
Total expenses	$124,249
Balance	$955,534

Out of this there was paid a dividend of 6 per cent. gold in June, 1873, and in January, 1874, another dividend of 3¾ per cent. gold was declared and paid and 2½ per cent. more declared, to be paid when collected. The capital stock is $5,000,000. The sum of $250,000 was carried to reserve account.

At the close of the year all of the stock, except 16 engines and 16 passenger cars, was employed; but since that time there has been difficulty in leasing new stock, or that received on the expiration of leases, and in some cases leases have been thrown up.

The balances due at the close of the year amounted to $282,026, of which $238,853 was from the Atlantic & Great Western. Much of this has been collected, and the trustees hope to make ultimate collection from every company except the amounts transferred to doubtful debtors already given above. But serious uneasiness has arisen concerning the amount due from the Atlantic & Great Western, owing to the peculiar circumstances in which the Rolling Stock Company finds itself placed with regard to the latter.

A large amount of narrow-gauge equipment was built for that road in view of the expected change of gauge; that change has not been made and much of the equipment is useless to the road. In view of these facts, the Rolling Stock Company readily consented to release the Atlantic & Great Western from its contract for narrow-gauge rolling stock, in so far as lessees could be found for the same elsewhere, and about 400 cars and 40 locomotives were promptly leased to other parties. But before further progress could be made the disastrous panic of September supervened, and not only paralyzed the Rolling Stock Company's efforts to relieve the Atlantic of its remaining narrow-gauge stock, but threw back on its hands a portion of that previously disposed of. The Atlantic Company now claims that for the latter it should be relieved from all responsibility. It further asks a concession on the rental of all the stock unused during the whole period of its standing idle, on the ground partly that the stock has undergone

no wear or depreciation, and partly that an equitable consideration is due to them for the disastrous results of that part of their lease contract.

Considerable repairs have been needed from the fact that much of the stock was built for Eastern roads and has proved too light for use on rough Western lines. This was notably the case with car trucks. The stock is now all in excellent condition.

Seaboard & Roanoke.

This company owns a line 80 miles long from Portsmouth, Va., west by south to Weldon, N. C.

The property is represented as follows:

Capital stock ($17,070 per mile)	$1,365,600
Funded debt ($2,625 per mile)	210,000
Total ($19,695 per mile)	$1,575,600

There is no floating debt, and the company has $568,769.22 invested in stocks and bonds of other railroad and steamboat companies.

The earnings for the year ending February 28 were as follows:

	1874.	1873.
Passengers	$95,496 96	$93,284 30
Freight	499,305 07	420,746 70
Other sources	55,820 14	52,587 95
Total earnings	$650,622 17	$566,618 95
Expenses	429,082 65	314,984 32
Net earnings	$221,559 52	$251,634 63
Earnings per mile	$8,133	$7,083
Per cent. of expenses	65.95	55.59

The increase in earnings was 14.82 per cent.; in expenses, 36.22 per cent.; and the decrease in net earnings, 11.95 per cent.

The work done was as follows:

	1874.	1873.
Passengers carried	33,984	26,300
Tons of freight carried	238,453	162,800

The principal items of freight were 237,969 bales cotton, 57,253 barrels naval stores, 6,855,000 feet of lumber and 1,674,000 staves.

During the year the country depots have been much improved; several wooden culverts replaced by stone; North street wharf in Portsmouth rebuilt; the roadway kept in good condition, and 600 tons of iron used in renewals.

Railroad Grade Crossings.

[A paper read before the Boston Society of Civil Engineers, June 5, 1874, by T. APPLETON, C. E.]

In the early history of railways, when their utility was a matter of doubt in the minds of many able men, the lines were located with very little regard to the future of the railroad system of the country. As other lines were built, it was frequently found necessary for one line to cross another in order to reach its objective points. In a majority of cases it was found that a grade crossing could be constructed at less expense in original outlay than would be required to pass one road over the other by means of a bridge. In those days, when railroads were still experiments, the inconvenience and danger of grade crossings were comparatively small; but with the growth of the system and the great increase of traffic, the danger and inconvenience increase in greater proportion, and at the present time the actual expense of a grade crossing becomes a considerable item in a year's expenses.

Probably the first grade crossing in the State of Massachusetts was that of the Boston & Worcester and the Boston & Providence railroads, both roads being opened in the year 1835. I am informed that to regulate the passage of trains over the crossing, it was originally the custom to give trains of the Boston & Providence Railroad precedence for six months in the year, and those of the Boston & Worcester Railroad to have precedence for the ensuing six months. With but half-a-dozen trains a day on each road such a system may have been successful, but to apply it at the present day would necessitate the closing up of one road during the time that the other had the right of way at the crossing.

The growth of the railroad system was so rapid that grade crossings soon became the scenes of many accidents from collisions of trains. In the year 1855 the Legislature of Massachusetts took the matter in hand and passed a law to the effect that all trains approaching a grade crossing should come to a full stop within 500 feet of the crossing, not to start again until a proper signal had been shown. As a majority of the Legislature of that year was of the "Know-Nothing" party, it was called the "Know-Nothing Legislature," and hence the stops caused by that law became known as "Know-Nothing stops."

It seems that no other means will make a grade crossing reasonably safe, and even in spite of the law collisions at grade crossings do sometimes happen.

At the present time there are forty-eight crossings of one railroad by another in this State, of which forty are at grade. In many cases, by a slight change of location, a crossing by bridge might have been substituted for a grade crossing with only a small increase in original expense, but either from parsimony or from lack of appreciation of the actual danger and expense of grade crossings, these opportunities have been neglected in constructing new roads. Local railroads have been built, crossing old-established through lines at grade, to the great inconvenience of the latter; while the former, with their light traffic, do not feel the inconvenience or the expense of the crossing.

Accidents at grade crossings are comparatively rare, yet the following statistics for the year 1873 show that they do occur: Of 11 collisions reported to the Railroad Commissioners in Massachusetts, 1 was a crossing collision; of 406 collisions reported by the RAILROAD GAZETTE in the United States, 30 were grade crossing collisions. I will not dwell upon the danger of such crossings; enough has already been said to show that they are far from safe.

The stopping of a train is inconvenient because of the loss of time. A train loses from one and a half to three minutes by every stop, for the speed of the train must be gradually reduced to make the stop, and can only be gradually regained afterward, whereas if the train could pass on at a uniform rapid rate the same distance would be accomplished in much less time. When a certain time is fixed for running a train from one point to another every stop necessitates increased speed on some portion of the run in order to make the trip in the required time.

Increased speed brings with it increased wear of track and cars, increased power and consequently more fuel is required, and also increased danger.

The actual expense of a grade crossing shows itself in many ways. The crossing frogs are an expensive structure when under a heavy traffic. In some cases crossing frogs have been completely worn out in two years. The frogs at the crossing of the Boston & Albany and Boston & Providence railroads have proved themselves to be of superior construction; they were put in in 1869 and are still in good order, although subjected to very hard service. A set of crossing-frogs for double-track railroads costs from one to three thousand dollars, and with renewals every two or three years this becomes quite an appreciable item of expense.

There is no doubt that the unusual jolt of the cars in passing a crossing-frog subjects the rolling stock to great strains and increases the wear and tear. It has been stated by practical railroad men that the wear and tear of rolling stock caused by one grade crossing was equivalent to that caused by from five to ten miles of smooth track. Such frogs undoubtedly cause many breakages of flanges, wheels and axles.

Another large item in the expenses chargeable to grade crossings, and the one that I wish particularly to investigate in this paper, is the loss of power caused by stopping the train. To arrive at the amount of this loss let us analyze the movement of a train and the action of the forces that affect it. To start a train the engineer applies the force of the locomotive; if that force exceeds the resistance of the train, it moves; so long as the force exceeds the resistance, increasing speed is the result; when the force and resistance are equal, uniform speed ensues; should the resistance exceed the force applied, a retarded speed will follow. In moving a train the locomotive exerts a force of a certain number of foot-pounds. The resistance of the train is another smaller number of foot-pounds, the excess of force of the engine over the resistance of the train, which gives the train increased velocity, becomes stored up in the train, and is called a "moving force" or "momentum" of so many foot-pounds. Philosophy tells us that this moving force is in proportion to the weight of the train multiplied by the square of the velocity, and is measured by one-half the mass of the train multiplied by the square of the velocity, represented by the expression $\left\{\frac{M\ V^2}{2}\right\}$. So we find it possible to compute the moving force of a train at any time, knowing its weight and velocity.

To stop a train we shut off steam and thereby stop the force applied to the locomotive, and destroy the moving force already acquired by the train by applying the brakes or by the slower process of allowing the resistance of the train to gradually use it up. Now how much force do we lose by stopping the train? Let us recapitulate. We start the train and acquire a high velocity by applying a force greater than the train resistance; we maintain the velocity by applying a force just equal to the train resistance; we stop the train by discontinuing the force applied and destroying the moving force which we have put into the train. When we start again we must replace the stored up force that we destroyed before we can acquire the same velocity that we had on shutting off steam. Clearly, the net loss of force is the amount of moving force in the train at the time of shutting off steam, represented by the expression $\frac{M\ V^2}{2}$.

[*Note.* The following notation will be used:
W = gross weight of train and engine in pounds.
M = mass = $\frac{W}{g}$
g = acceleration of gravity = 32.2
V = velocity of train in feet per second.
r = coefficient of resistance of train.
i = inclination of grade.]

Example A. A passenger train weighing 340,000 lbs. and moving at the rate of 32.6 miles per hour, or 48 ft. per second makes a stop. What is the loss of force?

Here W = 340,000 and V = 48

$$\text{hence } \frac{M\ V^2}{2} = \frac{W}{2g} V^2 = \frac{340{,}000}{64.4} \times 48 \times 48 = 12{,}248{,}278 \text{ ft. pounds.}$$

Example B. A freight train weighing 684,000 lbs. and moving at the rate of 17.8 miles per hour, or 26 feet per second, makes a stop. What is the loss of force?

Here W = 684,000 and V = 26

$$\text{hence } \frac{M\ V^2}{2} = \frac{684{,}000}{64.4} \times 26 \times 26 = 7{,}179{,}844 \text{ foot pounds.}$$

The foregoing examples are actual cases that have come under my notice. As the loss is in proportion to the square of the velocity, we find the passenger train loses much more than the freight, for although the latter is twice as heavy it moves at about one-half the speed of the former.

It will be seen that it is a comparatively easy matter to compute the loss of force in foot-pounds required to make a given stop. Now if we could find the number of foot-pounds developed by the locomotive per pound of coal, we could determine the exact loss in coal, and consequently the expense of fuel for a given stop. This is a somewhat difficult matter. Possibly it could be determined by means of indicator diagrams, taking both ends of both cylinders of the locomotive for a certain time, the amount of coal used during that time being measured. Perhaps the same thing could be accomplished by using a dynamometer, taking a diagram from it and measuring the coal used for the same period of time. I have not found, after diligent search in libraries, any record of experiments of this nature.

Another method would be to note the coal burned and the speed and weight of train while passing over a piece of known grade. The train resistance could be calculated by Gooch's or Clark's formula, and the duty of the engine thus obtained. I find in "Trautwine's Pocket-Book," page 411, an example containing all the data necessary for this method of computation. "An engine hauled a train of 105 36-100 tons gross weight up a grade of 95 feet per mile for 12 miles at a speed of 20⅓ miles per hour; the amount of coal used on the 12 miles was 1,073 lbs." Let us calculate the total amount of work done.

The formulas of Gooch and Clark for train resistance differ somewhat, but as I am unable to say which is the nearest right, I will use a result found by averaging the results of the two formulas. For a velocity of 20⅓ miles per hour, this gives .00372 as a coefficient of resistance.

The conditions of the problem then are:

(C)

W = 105.36 tons = 236,000 lbs.
V = 20⅓ miles per hour = 30 feet per second.
$i = \frac{95}{5280} = .018$
and r = .00372

Hence we shall have:

Resistance due to grade = 236,000 × .018 =	4,248 lbs.
" " " traction = 236,000 × .00372 =	878 lbs.
Total resistance =	5,126 lbs.

Multiplying the resistance by the path described, we have the

Work = 5,126 × 5,280 × 12 = 324,783,360 foot pounds.

But as we started the train from a state of rest, and have imparted a velocity of 20⅓ miles per hour, to obtain the total work done we must add the momentum or stored-up work in the train.

Take the formula $M V^2 = \frac{W V^2}{g}$, then

$$\frac{M V^2}{2} = \frac{236{,}000}{64.4} \times 30 \times 30 = 3{,}298{,}137 \text{ foot-pounds.}$$

Add this to the train resistance before computed, and we find the total work done = 328,081,497 foot-pounds.

As this was done by the consumption of 1,073 lbs. of coal, the duty per pound of coal is

(D)

$$\frac{328{,}081{,}497}{1{,}073} = 305{,}761 \text{ foot-pounds.}$$

Applying the same calculations to some experiments I made on a Massachusetts railroad, I find the following as the duty of the locomotive per pound of coal:

Case	I	299,781 foot-pounds.
"	II	248,789 " "
"	III	247,629 " "
"	IV	248,594 " "

Now if we assume a duty of 250,000 foot-pounds per pound of coal, as is indicated by cases (II), (III) and (IV), and apply it to the examples (A) and (B), we shall have the loss of fuel due to stopping:

(E)

Example (A) gives

$$\frac{M\ V^2}{2} = 12{,}248{,}278 \text{ foot-pounds;}$$

$$\text{hence } \frac{12{,}248{,}278}{250{,}000} = 48.99 \text{ lbs. loss of coal.}$$

(F)

Example (B) gives:

$$\frac{M\ V^2}{2} = 7{,}179{,}844 \text{ foot-pounds;}$$

$$\text{hence } \frac{7{,}179{,}844}{250{,}000} = 28.72 \text{ lbs. loss of coal.}$$

Assuming a duty of 300,000 foot-pounds per pound of coal, as indicated by cases (D) and (I), the results become:

(G)

Example (A) ..... 40.82 lbs. loss of coal.

(H)

" (B) ..... 23.93 " " " "

These results, although only approximate, indicate that the loss of fuel caused by stopping a train is really an important item.

In the fall of 1873 I made some experiments with a view of testing these theoretical calculations, some of the results of which I have used in the foregoing examples. The method of making the experiment was this: at a certain stopping place we measured the coal put into the fire-box of the engine until we had reached a point one mile distant from the starting point. Another mile of road was marked off having the same grade as in the first instance, but being differently situated in this respect, that the mile was commenced with the train under full headway. The coal was measured on the second mile as on the first, by means of a small box, the weight of the box-full being known. When the circumstances were alike, the difference between the amount of coal used on the first mile and that used on the second would indicate the loss occasioned by stopping the train. A number of experiments were made upon four different trains, and below I give the average result:

(K)

	Loss.
Case I	41 lbs.
Case II	49 "
Case III	49 "
Case IV	34 "

Taking the average weight of each train and the average velocity of the train when shutting off steam for the stop, we get the following results:

	2.	3.	4.	5.
Case I	12,021,490	48.08	40.07	41
Case II	7,180,472	28.72	23.93	49
Case III	14,626,998	58.51	48.75	49
Case IV	12,896,119	51.58	42.98	34

In the second column are the losses in foot-pounds of momentum. The third column gives the corresponding loss of coal, assuming a duty of 250,000 foot-pounds per pound of coal. The fourth gives the loss, assuming a duty of 300,000 foot-pounds per pound of coal; and the fifth the loss of coal ascertained by experiment and shown at (K).

Although with the means at my command I could devise no better method of ascertaining the loss of fuel, yet the process was only an approximate one. There are so many causes affecting the conditions of the case that it is almost impossible to make a just and accurate deduction in this way. In the first place the quality of the coal is exceedingly variable, even in the same tender-load. Secondly, it is impossible, even with the best intentions on the part of the fireman, to keep the fire at a uniform height in the fire-box. On one mile he might unwittingly increase the amount of coal in the furnace, while on another he might not supply enough to maintain the fire at a proper height. In making the records of the experiments I endeavored to allow for these accidental irregularities. This, however, changed the basis of the experiment from accurate measurement to the guessing of an amateur.

Granting all that may be said of the incompleteness of the data and the inaccuracy of the experiments, you must still allow that the waste of fuel caused by unnecessary stops is considerable. Taking the smaller figures as the average loss, say 40 lbs. for a passenger and 24 lbs. for a freight train, what a large total it will make in one year for a road having only one grade crossing!

Suppose a road to have 40 passenger and 10 freight trains each way daily (and some of our Boston roads exceed that number), what is the loss per day and per year?

Here we have:

Passenger trains	80 × 40 = 3,200 lbs.
Freight trains	20 × 24 = 480 lbs.
Total daily loss	= 3,680 lbs.

This for 313 days gives 1,151,840 lbs., or 514 gross tons. If the cost of this coal is $6 per ton, the actual annual expense from this one item is $3,084, and is 6 per cent. interest on $51,400.

In making a summary of the disadvantages of a grade crossing I would include:

1. Expense of fuel for making "Know-nothing stop."
2. Wear and tear of track and rolling-stock.
3. Cost and maintenance of frogs.
4. Cost and maintenance of signals.
5. Wages of signal-men.
6. Liability of accident from collision.
7. Liability of accident from passengers getting on and off.
8. Loss of time.

The first five of these items can be represented by a sum of money, say $60,000 for a road of the capacity indicated above; but the last three items may possibly cover a much greater loss.

These figures suggest to an engineer that if he is comparing two routes for an important railway, one of which invoives a grade crossing and the other avoids it, although at an expense of $60,000 additional, it will be true economy to choose the line which avoids the grade crossing, other things being equal. Again, since every train loses from one and a half to three minutes in making a "Know-Nothing stop," if the bridge route should be a mile longer than the grade crossing line, they would still be on an equality as regards running time.

I present you these ideas to-night, not because of any novelty of the subject, nor with the thought that my discussion of it is exhaustive, for I feel that here is an immense field for investigation and experiment, of which I have but just crossed the boundary, but with the hope that my humble efforts may be the means of attracting the attention of other and abler minds to the consideration of a subject that has hitherto received but little thought.